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AGRICULTURAL ENGINEERING

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A.S.A.E. Annual Meeting • *Portland, Ore., June 21-23*

THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Air-Power Spares Horsepower

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● It is no trick to get grain or forage into a hammer mill and reduce it to particles of desired size. The engineering problem is to get it out of the grinding chamber before repeated contact with the hammers has made some of the material too fine, caused more or less heating, and wasted power in the process.

Case hammer mills save substantial amounts of power in the grinding chamber by using sufficient power at the fan to pull ground material promptly through the screen. Less obvious but similarly significant are the relations between linear and angular velocities at the grinding circle, also the space relations among the hammers and with the screen.

Fast grinding of tough grain or forage calls for keen edges. Case hammer tips have eight edges; you loosen a bolt and turn a new edge into position. Sharp edges, clean scavenging, and good geometry in the grinding chamber—these are reasons for the fast, cool, relatively uniform grinding of Case hammer mills.

Designed for fast work with the power of farm tractors, these mills hold down power cost per bushel. More important, they grind more bushels per man-hour, push upward the final yield per man which is the essence of productivity and prosperity in agriculture. J. I. Case Co., Racine, Wis.

CASE

EDITORIAL

Serving Farm Markets

HOW can manufacturers best serve the farm markets for engineered materials and for mechanical, electrical, and structural equipment?

Top managements of the legion of manufacturers newly attempting to serve this market, as well as many of those who have been at it for years, may well take cognizance of some recent remarks by Deane G. Carter, professor of farm structures in the agricultural engineering department of the University of Illinois, in an address at St. Louis, Missouri, April 15, before the 30th annual meeting of American Zinc Institute.

While he was addressing manufacturers of building materials and equipment, his remarks apply equally well to manufacturers of other items for use in farm production. He suggests the way to a solid position in the farm market by outlining four common policies and practices which operate to defeat this objective, as follows:

"There is danger, however, that the manufacturer may fail to give the fullest service to his farm customers. This certainly will be true under the following conditions:

"1 If he uses the 'farm market' as a secondary outlet to be exploited only when other business is slack

"2 If he confines his selling to the 'cream' territory without providing service to the leaner areas where the need is greater

"3 If he limits his responsibility to selling without following through with directions, information, and education, to assure the best possible installation and use of his product

"4 If he 'oversells' or promotes his material, irrespective of its best use, or without regard to the peculiar and complex requirements of farm-production buildings.

"These failures to serve the 'farm market' fully, each of which is a real case occurring within the past two or three years, are lost opportunities."

One obvious alternative to these unfruitful policies and practices is to get out of the farm market, by building adequate volume in other markets for which the manufacturer's organization has the necessary know-how.

The other alternative is to become fully qualified to serve the farm market, in matters of policy, practice, and personnel, as well as product.

The personnel ordinarily best qualified to put into effect the indicated policies and practices, and to improve products for farm use, are agricultural engineers. It requires interpretation of the manufacturer's product to the purchaser, in comparison with competitive products, in terms of operating capacity, service life, cost per year and per pound, correct application, limitations, use and maintenance methods, influence on farm practices, output, labor requirements, etc.

It requires interpretation of use requirements, field test experience, agricultural science, and similar factors to the manufacturer in terms of possibilities for product improvement, new products, new applications, and new use recommendations. It takes a man or men who can deal understandingly with farmers, agricultural scientists, and industrial engineers and management to establish an effective working relationship between them.

Older companies in the business of supplying farmers with equipment, building materials, and electric service have long recognized agricultural engineers as their most effective contacts with the farm market. In addition to employing one or more agricultural engineers, according to their current or desired volume of farm trade, they have invited, welcomed, and gone out of their way to establish contacts with agricultural engineers as a professional group. They have been glad to have agricultural engineers know the practical limitations of their products and the conditions under which those products could not be expected to give satisfaction, as well as the values of those products to the farmer under favorable use conditions.

Only reasonably correct selection, care, and profitable use of production materials and equipment by the farmer can provide the sustained buying power and user satisfaction necessary to keep the suppliers of those items in business.

Agricultural engineers can help other manufacturers to realize this principle, to provide products with capacity for profitable farm use, and to further the profitable use of those products in the mutual interest of the farmer and the manufacturer.

Coordination of Production Mechanisms

WE WERE gratified to note in a recent issue of a farm implement trade paper, a comparison of costs of ownership and custom hiring of several specific farm machines.

This is an example of a constructive approach to better understanding between dealer and farmer. It emphasizes their mutual interest in sound economy in the farmer's hiring or purchase of farm production equipment. It clearly pictures the high cost of low use of equipment. It is an appropriate step in the direction of helping dealers to sell on a sound sales engineering basis, and farmers to buy on a sound production engineering basis.

It suggests a broader consideration of the farmer's problem as to the extent of capital investment in production equipment, and the combination of specific items, which he may be able to use most effectively to achieve low-cost production.

General principles of sound capital investment in production equipment have developed with the industrial evolution of mass production.

Possible alternatives and opportunities for choice in capital investment increase with the variety, refinement, complexity, capacity, and possible working combinations of production equipment.

The difficulty of making a good choice increases with the the number and complexity of available alternatives.

The importance of making a good choice increases with the cost of individual equipment units, the number of units, the scale of operations of the productive enterprise, competition to lower coasts, and the proportion of total product cost represented by investment cost.

Thus engineering development and refinement of individual units of production equipment leads to a further opportunity to improve production efficiency. It is the opportunity to apply engineering principles to a whole production enterprise as, in effect, one production machine; and to deal with its individual machine and structural units, combinations, layouts, routings, operations, and methods as related physical factors influencing the over-all efficiency of the whole production mechanism.

It appears that agricultural engineering has arrived at this stage in its progress. Opportunity for greatly increased application of these principles in agriculture is indicated by examples of prosperous, well-equipped farms; by the known wide range in production efficiencies of various farmers; by the very existence and progress of the farm equipment industry. Opportunity to improve farm production efficiency, by technically and economically sound combinations of production equipment units, compares favorably with opportunity for further development and refinement of individual structures, prime movers, process mechanisms, and controls.

Future progress in either of these fields of applied agricultural engineering will suggest opportunities for further progress in the other. We look forward to their parallel and mutually supporting development.

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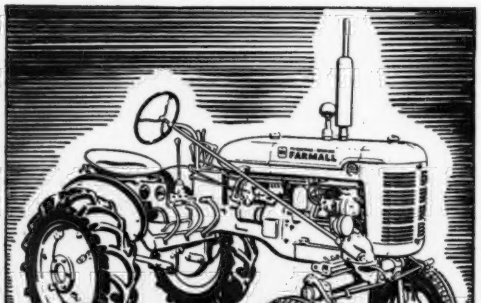
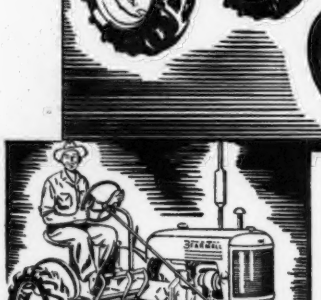


Left: Farmall Super-A offers hydraulic Farmall TOUCH-CONTROL and new "combustion control."



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AGRICULTURAL ENGINEERING

VOL. 29 MAY, 1948 NO. 5

The Engineering Development of a Light, Two-Row, Tractor-Mounted Corn Picker

By A. H. Keller

ONE of the later additions to the International Harvester line of corn pickers is the No. 24 picker. It is a light, two-row, tractor-mounted corn picker that is easily attached to or detached from the company's Farmall "H", "M", or "MD" tractors. It weighs slightly less than 2000 lb, and in its original conception was designed to meet the requirements of the corn grower primarily interested in gathering his own acreage. While it has not been recommended for custom operation, we have reports of some of these pickers that have harvested well over 1,000 acres in a season and in a manner comparable to our 2M picker; and even in some instances have received the comment that it gets more corn, which is due to its low-angle gathering points and sheets and gatherer chain and snapping roll relationship to the ground.

This machine was originally conceived in the year 1940. At that time it became apparent that the sales volume of corn pickers of a particular type could reach 10 to 20 thousand units annually—that is, a corn picker of lighter weight, one that would easily go on or off a tractor, and last, but most important, at such a price as would enable the purchaser to use it profitably on smaller acreages.

With this in mind our company's corn picker product committee authorized the development of such a machine. While a product design engineer was assigned to the task of designing this machine, it is important to point out that the completed product is the result of the untiring efforts of a great many people. In this connection I wish to enumerate briefly the actual steps and individuals involved in successfully carrying out a program such as was done in the case of the No. 24 corn picker.

First, we have the product committee which consists of three members:

(a) A manufacturing representative, either the plant superintendent, works manager, or manufacturing supervisor.

(b) A sales representative who is the product specialist of the particular line of machines involved.

(c) An engineering representative, either the chief engineer or engineering supervisor.

These three men with their knowledge, background, and experience in their respective fields form the backbone of the program.

Second, we have the product design engineer and the group of men in the product engineering department assigned to lay out, detail, and otherwise bring the machine in question into a physical state.

Third, we have the manufacturing, research and planning group. This group consists of high-caliber men selected from all branches of a manufacturing plant, such as tool design engineers, planning engineers, engineering department representatives, cost men, time-study experts, representatives from the inspection department, and representatives of the bundling, packaging, and handling group. Their purpose is to estimate costs on new products as well as conduct an intensive program of what we call cost reduction throughout the period of development of a product and afterwards still scratch for any extra pennies or mills that can be taken out of the cost during actual production runs.

The correlated duties of the product committee, engineering department, manufacturing, research, and planning departments is to control the design of the new product in such a way that functionally all requirements of satisfactory field operation are maintained, that from a manufacturing standpoint the new product will fit into the plant structure, and, above all, that product costs and tooling are kept down to an absolute minimum. While this is the goal in the development of any new product in any organization, we have found this system to be very effective because it takes all the guesswork and wishful thinking out of production and places the responsibility in a broad plane which results in utilizing the ideas and abilities of the entire organization.

Fig. 1 The International Harvester No. 24 corn picker in actual field operation

The No. 24 corn picker was developed with this method of control and the stages it passed through are as follows:

1 From 1940 to 1944 various designs of a low-cost, lightweight picker were tested in the field, at the end of which time the functional requirements of such a machine were firmly established.

2 After the concentrated studies of cost reduction were completed, twenty-five machines were produced for

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Power and Machinery Division.

A. H. KELLER is chief engineer, East Moline Works, International Harvester Co., East Moline, Ill

the 1945 season embodying all the qualifications demanded by the sales and manufacturing departments. These machines were not produced by tooling equipment that would be necessary for quantity production, but by job shop methods through the united effort of the engineering department and manufacturing with tools on hand, and only those tools specially provided where, if the machine parts were not fabricated as planned for quantity production, might result in structural failures due to a lack of the field testing so necessary to prove a product. The special tools were so provided with the thought of being utilized in the anticipated production runs. The machines were completed in ample time to reach the scattered localities to secure the benefit of an entire season's run. The territories to which these machines were shipped ranged throughout the areas in which corn is grown —from Texas on up through the corn belt and into the East, including one in Canada. In this way every conceivable crop condition was encountered, and needless to say while those machines represented the best efforts of a very conscientious group, they still had plenty of shortcomings.

During the entire season that these machines were in operation—and they were being operated by the farmers to whom they were allocated—their performance was checked periodically by field engineers, the designing engineers, and members of the product committee, and—I shouldn't omit the field mechanics who occasionally carried a bundle of parts to keep some particular machine in the running. Nevertheless all this experience paid off because we were making corrections and improvements simultaneously with the scheduling of this machine for full production.

After this was done, we should have been satisfied that here at last was a machine that had everything the doctor ordered, and now let's turn the crank and get rolling! But no; the members of the product committee decided that we select five men and assign to each of them five of these machines for the purpose of making a survey in the company of the service manager of the branches to which the machine had been allocated and in the presence of the operator to whom the machine had been assigned. In this way all mechanical defects were uncovered, and comments relative to improvement noted, which comments were solicited from the service manager and the operator, or anyone else who wished to offer constructive criticism.

The results of this survey were astonishing. After compiling the twenty-five individual data sheets from five different individuals they unmistakably pointed out further need for changes and improvements, if we were to produce on a full-scale basis a machine that would give the purchaser long, trouble-free service. This survey resulted in 227 changes and improvements on the No. 24 picker that otherwise would not have been made. These changes were immediately incorporated in the design of the machine for production in 1946. While a limited production in 1946 generally gave a good account of itself, we still made changes in our design for 1947 as a result of observations during the 1946 picking season.

As early as October, 1947, we completed our full schedule of No. 24 pickers for the 1947 season and enjoyed a fairly successful year. I might add, though, that the job is never-ending, and we will still be looking for ways of improving the performance of this picker.

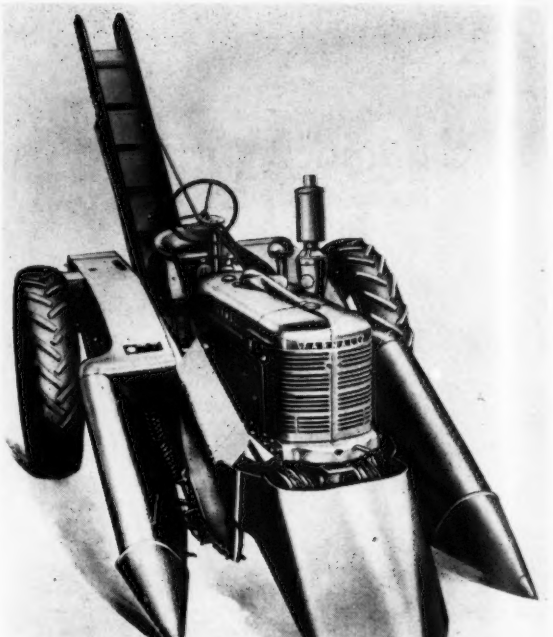

Fig. 2 A general view of the IH No. 24 corn picker, showing the favorable position of the operator with respect to the different parts of the machine

Now that I have discussed this corn picker as it is today, I will review the features of the machine that we feel are outstanding and that contribute to its success.

Fig. 2 shows the picker in general and clearly illustrates its clean appearance, also the favorable position of the operator with respect to the different parts of the machine. The operator is afforded good vision of the crop he is harvesting as well as a good view of all the units of the machine. He is safely situated away from all moving parts and has the controls for the picker readily accessible. These are two in number: (1) the hydraulic-lift control lever for regulating the height of the gatherers, and (2) the wagon elevator throw-

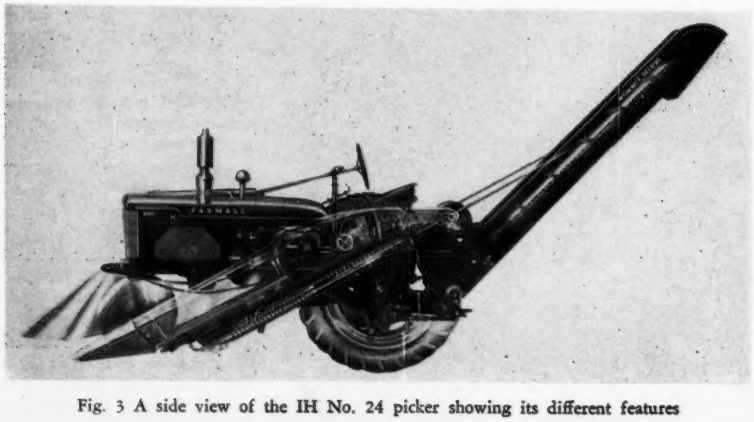

Fig. 3 A side view of the IH No. 24 picker showing its different features

Fig. 4 This phantom view gives a fairly good idea of No. 24 IH picker drives

out clutch to stop the elevator when making turns.

There are only a few other adjustments on this picker, and they are made by the operator when the machine is not in operation and are for the purpose of meeting field and crop conditions. These adjustments are five in number and consist of the following:

1 An adjustable tie bar that permits setting the gathering and snapping units to the proper spacing to accommodate varying row widths of corn planting. This adjustment covers a range of row widths from 35 to 44 in.

2 A conveniently located snapping-roll adjustment on the outside of each unit makes it possible to quickly and easily adjust the snapping roll relation to suit field conditions. The adjustment is made by merely turning an adjusting bolt clockwise to close up the rolls, and counter clockwise to open them up. This feature is a decided improvement over the method we have employed previously. The old method required the use of pliers, several wrenches, considerable time, and the better part of a man's disposition, because of the fact that he had to get down under the machine in mud, snow, or what have you to make an adjustment which, after being made, he wouldn't be sure of. As a result, this important adjustment was generally neglected until things got pretty bad. With this new convenient method an operator will adjust his rolls as often as necessary, and consequently do a much better job of picking.

3 Another factor that is a big help to the operator is maintaining relationship of the picking units to the ground, which is controlled by a chain extending from the tractor frame to the picking units. By adjusting the length of this chain to permit the units to drop to a predetermined picking height, the operator can forget positioning the units after making turns or going over or through certain terrain that necessitated raising the picker units. This adjustment is generally made upon entrance to a field, the condition of which will generally indicate at what height the units will be best positioned.

4 Another convenient adjustment for correct field operation is the range of flotation of the center and the two outside dividers which are easily adjusted to coordinate with the relation of the two picking units to the ground. This adjustment is made by use of the snap hooks and chains provided. The center divider besides being floatable is also steerable with the front wheels, upon which the center divider is mounted. The maneuverability this feature affords is remarkable in addition to its almost human ability to get underneath down and tangled corn and properly guide the corn into the snapping unit. Along this same line, it is important to note the low angle of these dividers and gatherer sheets which is the main reason for this picker's ability to get very high percentages of total crop yield out of fields even though the crop is in a congestion of down and tangled stalks.

5 The fifth adjustment to be made by an operator, while not as critical as the aforementioned ones, will add greatly to the quality of the work done by the picker if properly utilized. It merely consists of changing the sprockets on either end of the main drive jackshaft to suit the speed at which the machine may be efficiently operated. The speed of operation is controlled by various factors such as light or heavy yield, weed infestation, corn borer, or the variety of terrain that exists in the fields that are planted to corn. Just as a matter of record and to see what one of these pickers could do in a sort of marathon affair, we picked continuously for 22½ hr, and in that time covered 54.5 acres in corn that averaged approximately 40 bu to the acre. It is reasonably safe to state that the picker is capable of picking 2 to 3 acres an hour in average conditions.

Most of the above-described features of the No. 24 picker are shown in Fig. 3.

Now that the adjustments of this picker have been covered in this paper, we can review the related parts of it to bring out the reasons it can do all we claim for it. However, it is not to be expected that the benefit of various features built into this machine will be realized unless all the adjustments referred to are made.

First, note in Fig. 3 the lower gatherer chains and the ability they have to sweep the ground and gather up stalks and deliver them to the snapping roll, even though they lay parallel to the line of the row being harvested.

The snapping rolls while not a radical departure from the accepted practice of snapping corn with rolls, they are decidedly different in configuration. While the design of these rolls was one of necessity in this picker, we have gained the advantage with them of doing very little shelling even under extremely adverse conditions.

When I say the design is one of necessity, I mean that the rolls, while needing the ability to take every conceivable type of material through them, still cannot present an aggressive surface to the snapped corn, inasmuch as the rolls act as the elevating surface for the snapped corn. In explanation of this, we do not have what is normally referred to as a first elevator, that is generally positioned to one side of the snapping rolls for the purpose of transporting the snapped ears either to a hopper as in a straight corn snapper or to a husking bed as in a combination snapper and husker. In this picker the ears of corn after being snapped are transported over the remainder of the snapping rolls, and thence over the husking rolls, which are a continuation of the snapping rolls inasmuch as they are directly in line with the snapping rolls. This operation is accomplished by means of a chain with lugs which

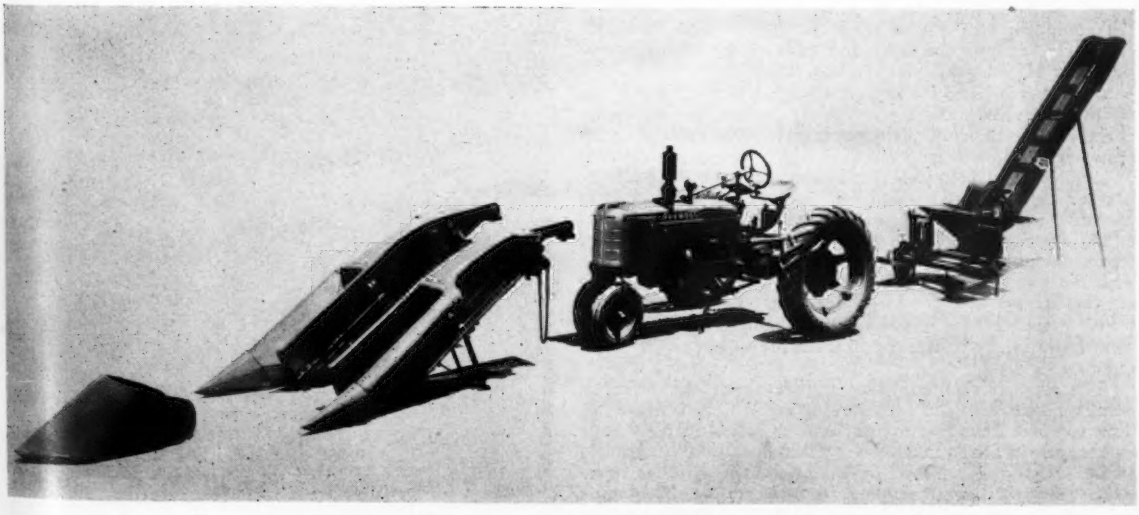

Fig. 5 This shows the simplicity of attaching and detaching the No. 24 picker

Fig. 6 This view suggests the method of storage of the No. 24 IH picker

acts both as a gathering chain and first elevator chain.

The surface of the rolls in contact with the ears of corn prior to and after snapping is extremely smooth, thereby causing no shelling of the ears of corn. The base of the rolls and the sides of the continuous spirals of the rolls are studded with aggressive projections. This then gives the result necessary in this type picker—spiral rolls that can be interlaced in adjustment or opened up to whatever position is necessary to get the stalks, foliage, and various types of foreign material through, but still present no aggression to the ears of corn while being removed from the stalks, or during the period of time they are being transported over them. The possibilities of this combination of features in a snapping roll are unlimited. We can cite one, in that the picking of pop corn can be done very successfully by merely adjusting the roll clearance to practically a minimum.

The husking rolls which are a continuation of the snapping rolls have replaceable rubber inserts and afford a very efficient unit.

At a point directly over the husking rolls and to the rear of them, we have positioned a two-winged beater chief function of which is to take care of the straggler stalks that didn't go through the snapping rolls for various reasons. It also acts as an impeller for the ears of corn in their eventual delivery to the wagon elevator hopper.

After the ear of corn has been carried over the snapping and husking rolls, it is then dropped through a cleaning blast of air that is directed from a centrally located two-directional fan equipped with a cast aluminum rotor. This operation effectively removes the odds and ends of trash that would otherwise be delivered into the final sample.

The corn in its so far straight-line path through the picker is now received by the large capacity hopper, and by its inclined surface the corn is slightly diverted to a centrally positioned wide, deep wagon elevator which has ample capacity to handle the highest yields so far encountered. The hopper has sufficient storage capacity to hold any amount of corn necessary while making turns. The wagon elevator is pivoted at the same point as the center of drive to allow upward movement of the wagon elevator in case it comes in contact with the wagon as may occasionally be experienced when going through washouts and making turns.

Now that I have discussed the handling of the ear of corn, I will briefly review the attachability of the picker to the tractor.

The simplicity of attaching and detaching the picker is best explained with the assistance of Fig. 5, which illustrates three compact units that are put onto or taken off the tractor by one man in fifteen minutes for either operation. It requires no heavy lifting, and there is but one chain that has to be connected at the time of removal from the tractor. The frame and elevator unit is supported by built-in jacks when removed from the tractor. They are readily retracted when the unit is

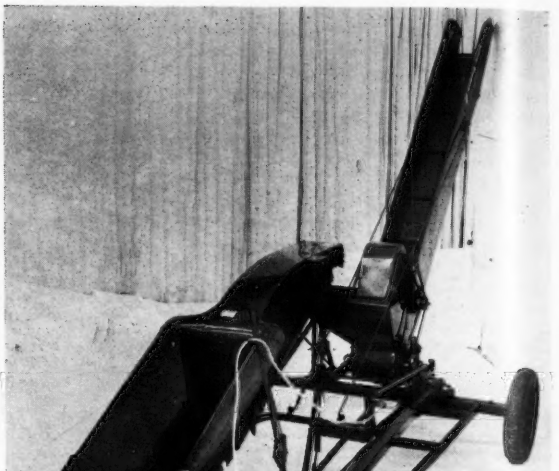

Fig. 7 This is a view of IH No. 14-P one-row, pull-type corn picker

attached to the tractor. The two combination snapping and husking units are supported by stands when off the tractor. They are easily removed and snapped into a carrying position under the outer gatherer sheets when the units are mounted on the tractor.

The cross pipe which spaces the two snapping and husking units also acts as a stabilizer for the two units when they are off the tractor and in storage.

The method of storage for this picker has also been given some thought, and Fig. 6 offers a suggestion. A minimum of space is used, and in this way an operator is likely to give some consideration toward shelter for this machine which, of course, in the long run will pay him dividends.

While all that has been reviewed up to now deals with the No. 24 corn picker in general, it seems in order at this time to give you a glimpse of what *(Continued on page 202)*

Fig. 8 This two-row, pull-type machine is the new IH No. 24-P corn picker

Effect of Conservation Practices on Runoff

By Neal E. Minshall

THE following discussion, of the effect of conservation practices on runoff, is based on nine years of records collected by the Soil Conservation Service on small agricultural watersheds on the Edwardsville, Illinois, and Fennimore, Wisconsin, demonstration projects. It is difficult to place a definite value on the effect of conservation practices on runoff with these data since nearly all of the areas have been in mixed crops for the entire period of record. The Edwardsville, Illinois, areas cannot be compared with those at Fennimore, Wisconsin, because of the wide difference in soil types.

EDWARDSVILLE, ILLINOIS WATERSHEDS

The soils of the Edwardsville areas are of loessial origin over glacial till with a claypan layer at a depth of 10 to 20 in, and have very low permeability. The areas considered here consist of W-III, a rotation-cropped 12.55-acre terraced field; W-I, a 27-acre cultivated area and W-II a 50-acre pastured area. W-I was cultivated with mixed crops prior to 1940, then all in alfalfa for three years in succession, followed by three years of mixed crops, while W-II has been largely in pasture for the entire nine years. Records on W-III cover only five years from 1938 to 1942, inclusive.

A good relationship exists between the annual totals of precipitation and runoff although rainfall intensities, amounts and distribution within the storm vary widely between areas and from one storm to another, and all these factors have an effect on the resultant runoff. This relation holds true for the calendar year as well as for other 12-month consecutive periods, no doubt due to the small accumulation of snow on December 31 of the average year. Computations were made for years beginning January 1, July 1, and October 1.

Fig. 1 shows the comparison between rainfall and runoff for areas under different conservation practices. These curves represent the average of all the 12-month periods computed. They show the least runoff from alfalfa and the most from the cultivated area, with the terraced-cultivated and pastured areas falling between these two extremes. It will be noted that half the record for W-I, cultivated, occurred prior to the alfalfa planting and the other half after the alfalfa planting. The relatively large amount of runoff from the pasture is due to the more severe erosion and the resultant poor cover on the steeper parts of this area. Results from other pasture areas, on the same soil types, at the McCredie, Missouri, Experiment Station (155 acres) and Muskogee, Oklahoma, (25 acres) agree well with the Edwardsville data.

A comparison made for ten of the heavier storms on W-I and W-II show a considerable variation in rainfall amounts and intensities, even between these two areas which are located about one-quarter mile apart. These variations are reflected in the maximum rates and total amounts of runoff. The rate of infiltration over these areas is not uniform because of the many variations in soil types and depths, topography, degree of erosion, density of cover, and rainfall intensities. Perhaps a better comparison of the effect of cover on runoff is shown by the total amount of moisture retained during a storm. Retention as used in these discussions, includes plant interception, depression storage, and infiltration, or, in other words, it is rainfall minus runoff.

Since W-II was predominantly in pasture for the entire period and represents the most uniform conditions of height and density of cover, the amounts of precipitation retained on this area reflect more nearly the effect of antecedent moisture and rainfall intensities than the retention on W-I.

Retention on the W-I area was higher than the W-II pastured area for the storms of July 17, 1938, July 8-9, 1942, and May 16-18, 1943. For the last two of these storms this is clearly a case of cover effect as W-I was 96 per cent alfalfa. The storm of August 4, 1940, shows a lower retention on the alfalfa than for pasture, which is probably a carry-over from the previous crop, as the new alfalfa did not have sufficient time to build up a good soil structure. The other six storms show higher retention on W-II than on W-I. The storms of August 14-15 and 15-16, 1946, with a total precipitation of about 9 in in 36 hr and both with high antecedent moisture conditions, show the retention for the pasture area appreciably higher than for the cultivated area which was then approximately 50 per cent in crops.

Infiltration rates, for these and other storms, were estimated from an examination of the runoff hydrographs and the histograms of rainfall. In making these estimates, it was necessary to assume values for plant interception and depression storage. Some allowance was also made for the time after cessation of rainfall during which infiltration continued at capacity rates on the entire drainage area. Even under good vegetative cover the minimum infiltration rates are low (less than 0.05 in per hr) which is a characteristic of the claypan prairie soils.

The variations in size, shape, and topography of these areas and the difference in rainfall intensities between watersheds, for the same storm, made it inadvisable to attempt comparisons of peak rates of runoff. If each of the areas had been in one cover for a number of years, it might be possible to compare rates of retention or rainfall intensities minus rates of runoff.

FENNIMORE, WISCONSIN WATERSHEDS

The Fennimore, Wisconsin, experimental areas are in the unglaciated section of the southwestern part of the state. The

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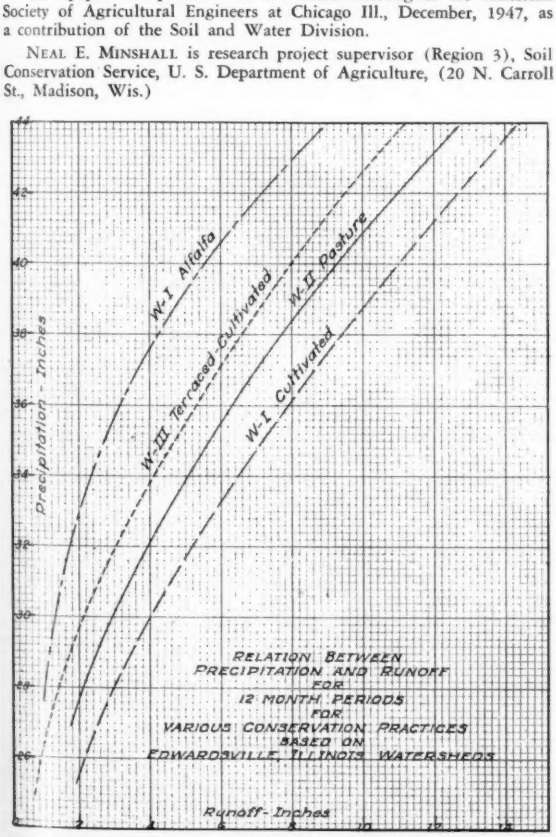
W-I Alfalfa
W-II Pasture
W-III Terraced Cultivated
W-I Cultivated
Precipitation - Inches
Runoff - Inches
RELATION BETWEEN PRECIPITATION AND RUNOFF FOR 12 MONTH PERIODS FOR VARIOUS CONSERVATION PRACTICES BASED ON EDWARDSVILLE, ILLINOIS WATERSHEDS

Fig. 1 Relation between precipitation and runoff for 12-month periods for various conservation practices

soils are of loessial origin underlain with limestone at a depth of more than 4 ft for most of the areas. None of these areas have been in one cover during any one year. Two of the areas have the same general shape, soils, and topography and give a fair comparison. The larger of these areas, W-IV (171 acres), had approximately the same percentages of the different covers for all the years of record. The smaller area, W-II (22.8 acres), has considerable variation in cover from year to year.

Because of the low amount of runoff from these pervious soils no good relation exists between total annual rainfall and runoff. Also some years have no surface runoff, except that from melting snow in the spring. The only comparison of any value in this instance is to find two or more storms with approximately equal intensities and like antecedent moisture conditions. The storms of August 12, 1943, and July 11, 1944, most nearly fit these conditions. Data for these two storms are show in Fig. 2. The precipitation for the 15 days preceding each of these storms was less than one-half inch. The corn acreage on W-IV was about the same for both storms, while on W-II the amount of corn on July 11, 1944, was about 12 acres, or more than double that on August 12, 1943. One other difference was that a large part of the corn on the W-II area was replanted late in June, 1944, and was only a few inches high on July 11, thus affording pratically no protection from the beating rain, whereas most of the corn was several feet high on August 12, 1943.

The chief difference of these two storms, as shown in Fig. 2, is that the intense part of the August 12 storm came after about one inch of precipitation in the preceding three hours, while the July 11 storm began with high intensities. Since W-IV had about the same percentage of cultivated areas for both storms, the effect of the difference in rainfall intensities and distribution is shown by the hydrographs in Fig. 2(b). The peak rate of runoff on W-IV for August 12, 1943, is three times that for July 11, 1944, while on W-II this ratio was about 1 to 7. The total runoff from W-IV on August 12, 1943, was more than double that of July 11, 1944. On W-II the total runoff on August 12, 1943, was less than one-third that of July 11, 1944. This comparison shows clearly the effect of an increase in corn acreage on W-II, but it is somewhat exaggerated due to the difference in height of cover.

The retention on W-II is 0.40 in higher on August 12, 1943, and 0.27 in lower on July 11, 1944, than the corresponding values for W-IV. The data given above shows that, for pervious soils, the effect of both height and type of vegetative cover on surface runoff is very pronounced.

Engineering a Corn Picker

(Continued from page 200)

will be new for 1948, and also what is coming in the not-too-distant future. First, I should explain that these two newcomers to our line are the offspring of the No. 24 picker. There is no mistaking their relationship in this respect, inasmuch as all major units are identical with those of the No. 24. It is what we consider a good job of standardization of product.

The No. 14-P (Fig. 7), which is the one-row pull machine, has had, because of this standardization of product, the benefit of the experience gained with the No. 24. However, we did go through all the same stages of development on it, as we did on the No. 24 in so far as the parts peculiar to No. 14-P are concerned. It is to be produced in quantity during our 1948 season.

The No. 24-P (Fig. 8) is the two-row pull machine and is the latest development of our picker program. With everything working out as planned, we should be in a favorable position to do something about a production schedule in 1949. As in the No. 14-P, we have in this machine all the benefits of our No. 24 experience plus that of the No. 14-P.

The simplicity of production gained by the use of standard major units in an arrangement of them as necessary for the particular type of product desired, has a far-reaching effect that reduces the burden placed upon a manufacturing plant when called upon to produce a variety of product. It also is very important when considering the service angle to the ultimate user, not forgetting to mention the stocking of parts, units, and machines at the dealer outlets and our branch organization. Then, too, the educational program so necessary when introducing a new product is practically eliminated when that new product is so closely related to one that has been introduced.

In conclusion, we believe that we have with the No. 24, the No. 14-P, and No. 24-P a line of corn pickers that will answer the requirements of all corn growers in any area under a great many conditions of operation.

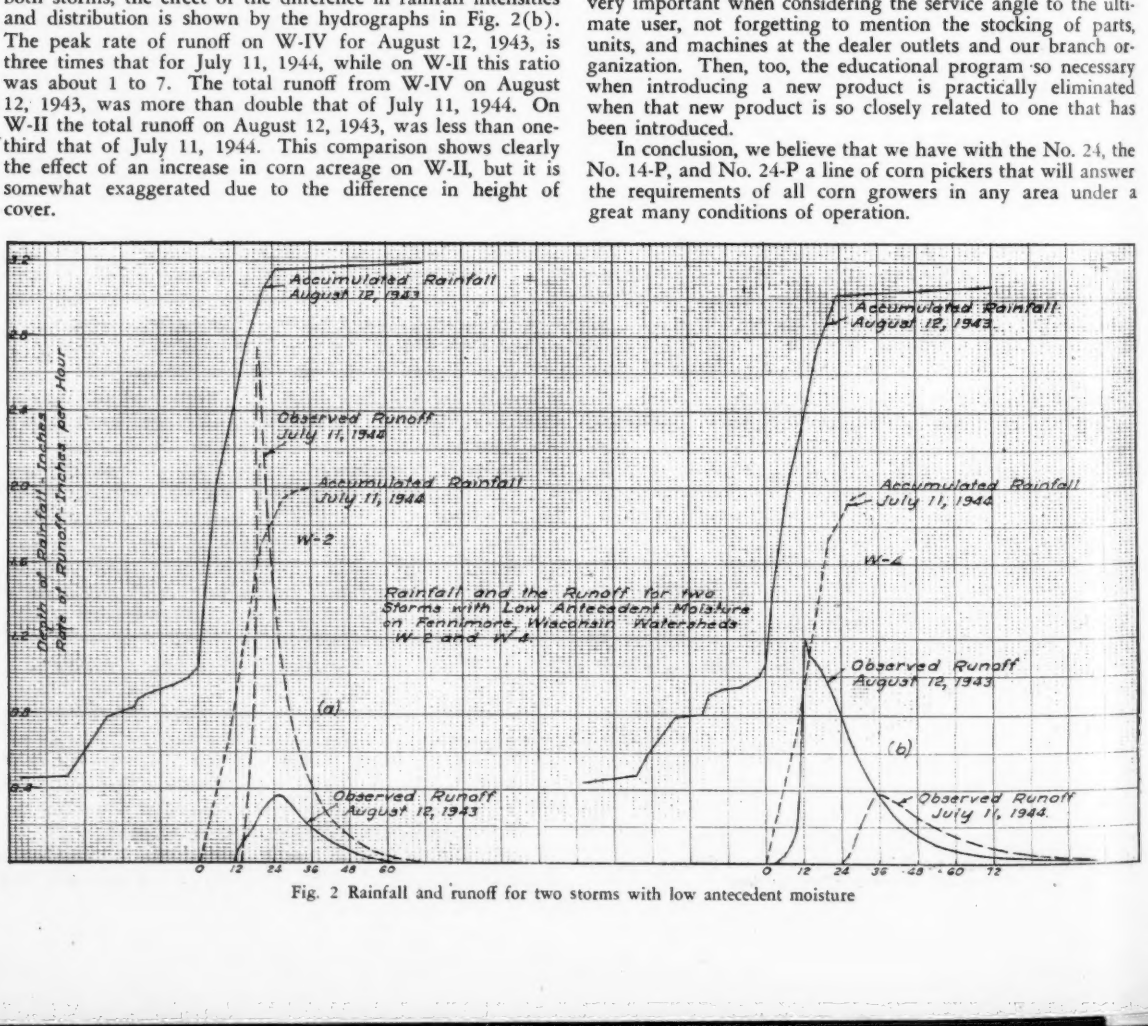
Accumulated Rainfall August 12, 1943
Observed Runoff July 11, 1944
Accumulated Rainfall July 11, 1944
W-2
Rainfall and the Runoff for two Storms with Low Antecedent Moisture on Fennimore, Wisconsin Watersheds W-2 and W-4.
(a)
Observed Runoff August 12, 1943
Depth of Rainfall-Inches
Rate of Runoff-Inches per Hour
0 12 24 36 48 60
Accumulated Rainfall August 12, 1943
Accumulated Rainfall July 11, 1944
W-4
Observed Runoff August 12, 1943
(b)
Observed Runoff July 11, 1944
0 12 24 36 48 60 72

Fig. 2 Rainfall and runoff for two storms with low antecedent moisture

Heating by Refrigeration

By Orville W. Zastrow

COOLING by mechanical refrigeration is commonplace. Familiar examples are the household refrigerator, the air-conditioned building, or an ice manufacturing plant. The same equipment works equally well for heating, even though that may seem unnatural to those of us who are not refrigerating engineers. However, the refrigerating cycle as used for heating deserves serious study, and its use is likely to be important in more ways than have been generally suspected.

Past experience in space heating with the heat pump, or reversed refrigeration, gives an indication of what may be expected. This method of heating has been highly satisfactory, under conditions for which it is suited, and its use is spreading. It is in use in several hundreds of buildings in the United States and in other countries. Some installations have been operating for ten years or more. Many of these are in offices and other commercial buildings; however, interest in the heat pump for residential use is increasing since the appearance on the market of package units in sizes suitable for the home. Several manufacturers now offer such units, which provide summer cooling as well as winter heating. Their operation is thermostatically controlled and completely automatic, including the reversal from heating to cooling, or vice versa.

It is important to note that this cycle does not depend on the compressor to produce the heat given off by the condenser, even though some heat is added by the compressor because of friction and the effects of compression. The main source of heat is the evaporator, which absorbs heat, leaving the space around it colder than it would be normally. The compressor is necessary only for maintaining the difference in pressure between the condenser and evaporator, so that heat can be absorbed at low temperature and given off at higher temperature. This action of transferring heat from a cold space to a warmer one by pumping a refrigerant is well described by calling the machine a heat pump.

To cool or air-condition a room, the air in the room is circulated over the cold evaporator, while air outside the house is used to carry heat from the condenser. If the room is to be heated instead, the evaporator can be warmed by means of outside air while the condenser heat is used to warm the room. Units for both heating and cooling can be equipped with extra pipes and valves to change the flow of refrigerant, so that the coil inside the house may be either an evaporator or a condenser, while the outside coil performs the opposite function.

Efficiency and the Coefficient of Performance. The power required for driving the compressor depends on the difference in pressure that must be maintained between the cold and hot sides of the cycle. These pressures are determined by the temperatures of the condenser and evaporator. The greater the temperature difference between the condenser and evaporator, the greater will be the pressure difference and the amount of power needed to operate the compressor for a given rate of heating or cooling.

For heating alone, the advantage of the heat pump over an ordinary resistance-type heater is that the heat pump uses less electricity to heat a given space. The resistance heater changes electrical energy into heat directly by passing the current through a coiled wire or other material. The motor of the heat pump uses electrical energy to drive a compressor which brings heat into the house from some outside source. For heat pump installations that are in use, the amount of heat furnished is usually more than three times as great as could be obtained by using the same amount of electricity in an ordinary space heater, even though the space heater is 100 per cent efficient in converting electrical energy into heat. This makes it possible to heat a house economically with a heat pump where the cost per kilowatt-hour is too high for direct space heating.

The coefficient of performance of a heat pump describes the amount of heat it will furnish, compared with a resistance heater using the same amount of electrical energy at 100 per cent efficiency. If the heat pump furnishes three times as much heat, its coefficient of performance is said to be 3; if it furnishes four times as much, the coefficient is 4. The coefficient of performance for heating depends on the kind of equipment used, the temperature of the source from which the evaporator absorbs heat, and the temperature of the air inside the house that is used to cool the condenser. Since the room temperature is usually kept near 72 F, the temperature of the heat source is the most important factor to consider in estimating what the coefficient of performance for a certain kind of equipment will be. The coefficient drops as the heat source temperature goes down. For a good installation using water at 55 F as a heat source, a coefficient of performance above 3.5 can be obtained with present equipment.

Cost Comparisons. In comparing the cost of electricity for operation of the heat pump with that of fuel for some other kind of heating system, it is necessary to consider the coefficient of performance that is likely to be obtained with the heat pump, the efficiency of the other system, and the price of electrical energy and other fuels. For well-installed heating systems with furnaces kept clean and fired properly, and with houses equally well insulated, operating costs compare approximately as follows: For a heat pump installation with a coefficient of performance of 3.5, fuel costs for heating will be equal for electrical energy at 1c per kw-hr, soft coal at $10.50 per ton, hard coal at $9 per ton, or fuel oil at 7.6c per gal[1]. For electric rates above or below one cent, the other equivalent costs go up or down in proportion.

The first cost of a heat pump completely installed is higher than that of a conventional heating system, but usually lower than that of such a system with air conditioning added. At present, the prices of complete package units suitable for residential heating and cooling range from $1000 to $3000 or more plus installation costs, which may be quite high in a house not built for air heating or cooling. In a new house designed for a heat pump, some savings may be possible in building costs as compared with conventional construction. For example, the chimney becomes unnecessary unless the home owner wants a fireplace. Window frame construction is simplified because the windows need not open. The fuel storage bin or tank is eliminated. However, it must be recognized that until the initial cost of the installation can be reduced, the heat pump will be more costly for house heating alone than other systems that are available. Factors that tend to offset this higher cost are the value of summer cooling, increased cleanliness, convenience, and reduced fire hazard.

Heat Source Requirements. The most difficult problem in designing a heat pump installation usually arises in connection with providing an adequate source from which heat can be absorbed. Outside air is satisfactory as a source of heat under some conditions, although a large volume must be handled to provide the amount needed to heat a house. However, winter air temperatures in most of the United States drop too low for efficient operation.

The earth offers an abundant supply of heat at reasonable temperatures, but the question of how to arrange most economically for this heat to be absorbed by the refrigerant needs additional study. The evaporator must necessarily be cooler than the heat source in order to absorb heat, but for economical operation this drop in temperature should be kept as

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This is an abridgment of a paper presented at the annual meeting of the American Society of Agricultural Engineers, at Philadelphia, Pa., June, 1947, as a contribution of the Rural Electric Division.

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[1] Calculated on the basis of fuel heating values of 14,000 Btu per lb of soft coal, 12,000 Btu per lb for hard coal, and 136,000 Btu per gal for fuel oil, with furnace efficiencies of 45 per cent for coal and 65 per cent for oil.

small as possible. If the evaporator has a large amount of surface in contact with the earth or if it is cooled with a generous flow of water, the temperature drop can be reduced to an insignificant value. However a large evaporator is costly to manufacture and install, and water is often not available in large quantities. A small earth heat exchanger or reduced flow of water can be provided more easily, but then the drop in temperature will be greater for an equal rate of heat absorption, so that the efficiency of the compression cycle is reduced. The ideal heat exchanger should be reasonable in cost, adaptable to varying conditions of water supply, soil, and subsoil conditions, and large enough in thermal capacity so that its temperature changes will be at a minimum as heat is absorbed or dissipated. Present manufacturers of heat pumps for house heating approach this problem in several different ways.

Equipment Available. At least two manufacturers have developed package heat pump units suitable for residential use, and several others are developing such units. These are equipped with automatic control systems that operate valves to change the operation from heating to cooling or from cooling to heating, as necessary, so that temperatures are maintained in accordance with the setting of a thermostat.

The 3 and 5-hp units have generally been adequate for small and moderate sizes of homes that are well insulated.

Agricultural Uses for the Heat Pump. Although space heating is the application that is getting the most attention now, there are other uses for the heat pump directly related to agriculture that need investigation. Possibilities for electric house heating are important to agriculture, for when heat pumps for house heating come within the reach of moderate-income city dwellers, farmers are going to have them, too, and a potential added load that can change a 2,000-kw-hr per year consumer to one using 12,000 kw-hr per year is something of importance, at least to the rural power distributor. Similarly, the heat pump water heater, which shows considerable promise, is at least as important to rural users as to any other group. Two other uses for the heat pump may be of special importance to agriculture.

One application that suggests itself is to perishable food crops storage and curing. Where refrigeration is necessary and where a considerable amount of heat is needed at other times for protection against freezing, a reversible heat pump unit may be the answer. A unit of this kind is used in refrigerator vans for motor transport of perishable foods. It operates for heating or cooling, using a gasoline engine with full automatic starting and stopping equipment. The change from cooling to heating is made manually, by closing three hand valves and opening three others. A similar unit could be operated with an electric motor where the power is available. If special curing temperatures within a reasonable range are needed for certain periods, a thermostatically controlled heat pump can maintain the desired conditions.

Another application of the heat pump principle is an interesting device called a vapor compression still. Stills of this type were used by the United States armed forces during the war to purify water for drinking and other purposes. When such a still is operating, a compressor draws off the vapor from the boiling liquid at atmospheric pressure and discharges it at a pressure of about 4 psi. The vapor under pressure goes into a condenser submerged in the boiling water. Since steam at 4 psi condenses at 222 F, the heat given off as it condenses is returned to the water boiling at 212 F and helps to maintain the process. Finally, the hot condensed water is cooled by make-up water for the still. The amount of heat supplied from external sources is small compared with the great amount that is recirculated to evaporate water into steam.

Where electrical equipment is used, resistance heaters heat the water to start the process, and then the compression cycle furnishes most of the heat to maintain it. Part of the resistance heaters are left on to make up for losses. The amount of heat added is made larger than necessary in order to stabilize operation; yet performance coefficients of 15 to 1 or higher are obtained with such equipment.

Similar equipment can be used with vacuum-evaporating pans for distillation at temperatures below 212 F. This process is used in Switzerland for concentrating milk, whey, milk sugar, and unfermented fruit juices[2]. According to the information now on hand, no equivalent process is used in the United States for concentration of agricultural products.

These are examples of possible uses that may be expected from the heat pump in applications related to agriculture. Others may be more valuable than the ones mentioned here. The development of new applications will depend at least partly on how accurately the capabilities of this equipment are evaluated. Limitations are its relatively high first cost, the need for an adequate heat source and its inability to furnish heat economically at high temperatures. On the other hand, the heat pump can offer advantages in cost over other methods of heating where the heat is used at moderate temperatures, where an adequate source of heat is available, and where the utilization factor is such that a higher first cost is justified. Furthermore, it is well suited for easy control or automatic operation, it does not produce dust or smoke, and it is able to provide cooling as well as heating.

[2]Baumann. Thermo-Compressor Installation in Lucens for Concentration of Milk. Brown Boveri Review, 30:5/6. Baumann and Marples, Some Applications of the Heat Pump as a Heating Machine. Brown Boveri Review, 30:7/8.

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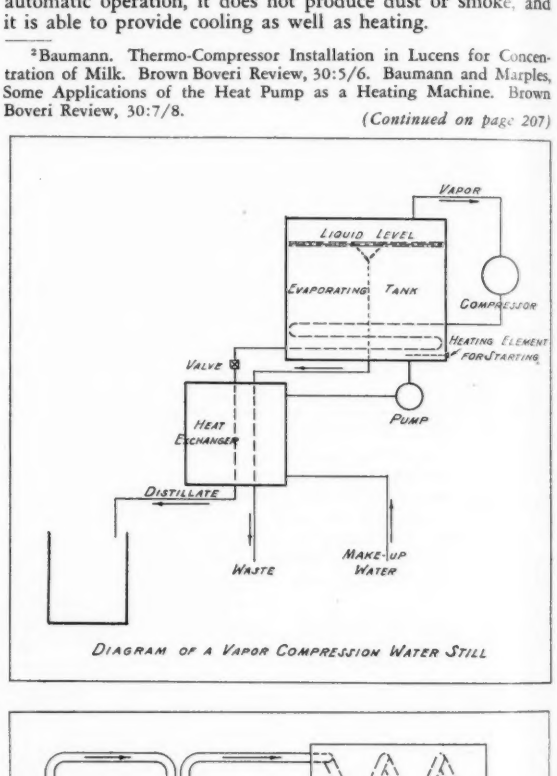
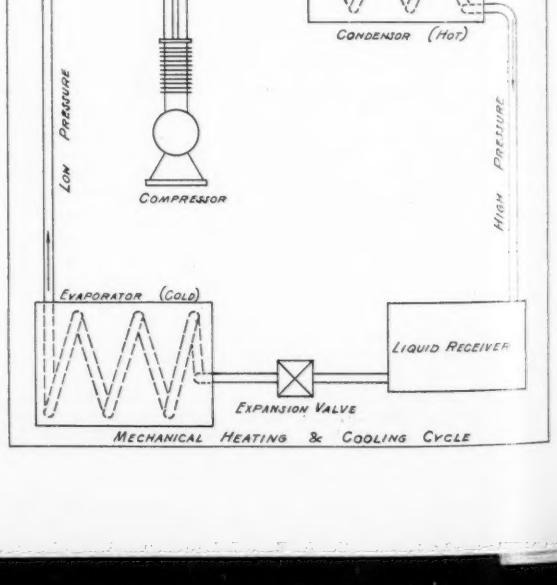


DIAGRAM OF A VAPOR COMPRESSION WATER STILL



MECHANICAL HEATING & COOLING CYCLE

Agricultural Hydrology Activities

By D. B. Krimgold, Chairman
MEMBER A.S.A.E.

IN ORGANIZING its activities, the A.S.A.E. Committee on Agricultural Hydrology set up the following objectives:

1 To promote the use of sound hydrology principles and facts in agriculture

2 To foster research in the field of agricultural hydrology

3 To aid agricultural engineers and others in performing professional work involving various phases of agricultural hydrology.

It was proposed to attain these objectives by (a) making available to agricultural engineers and others the latest information in the field of agricultural hydrology, (b) providing a forum where new ideas and findings could be presented and discussed, (c) determining deficiencies and shortcomings of basic scientific knowledge and facts needed in the effective application of agricultural hydrology, (d) calling attention of appropriate public and private agencies to the need for specific types of information and for appropriate lines of research, and (e) promoting and encouraging close collaboration with individuals and organizations in the field of agricultural hydrology, both in the United States and abroad.

To facilitate its work and to insure that none of the important phases of agricultural hydrology are neglected, the organization of the Committee provides for six standing subcommittees and such additional subcommittees as may be needed. It was intended that each subcommittee should undertake, in its phase of agricultural hydrology, what the Committee was endeavoring to accomplish in this field as a whole. The subcommittees were to utilize all the means available to the Committee, particularly symposia and round-table discussions. The Committee as a whole was to coordinate and facilitate the work of its subcommittees and was to take care of matters common to all phases. The need for coordinating its work with that of other committees of the A.S.A.E. Soil and Water Division was also recognized.

The statement in the January, 1946, issue of AGRICULTURAL ENGINEERING (p. 36) brought a letter from T. S. Forsaith, of the Dominion Experiment Station at Swift Current, Sask., in which he informed us that their station had under consideration runoff studies in southern Saskatchewan which might be extended to include Manitoba, Alberta, and British Columbia. He also asked the Committee for references and other information on the subject. Twenty bulletins and reprints, a list of 35 references, and a letter answering specific questions were sent Mr. Forsaith in February, 1946. He was invited to prepare a paper on agricultural hydrology in Canada and to participate in the work of the Committee. These invitations were accepted and we hope soon to hear more about the work in Canada.

The organization of the subcommittees was a task of major importance. We proceeded on the assumption that the chairmen of the subcommittees must not only be qualified in their fields, but must be willing to devote the necessary time to the work, and to get others to contribute. It was felt that, at least until the work is well under way, the chairmen of the standing subcommittees should be so situated as to insure frequent personal contact with the chairman of the Committee. So far four of the six standing subcommittees and one special subcommittee have been activated. These subcommittees and their chairmen are: Water-Plant-Soil Relationships, C. S. Slater; Ground Water, W. D. Potter; Evaporation from Water Surfaces, T. W. Edminster; Runoff, D. B. Krimgold, and Watershed Studies (special), L. L. Kelly. There are no chairmen as yet for the Subcommittee on Precipitation and the Subcommittee on Erosion and Sedimentation. Statements of the scope, objectives, and plans of these subcommittees were published in the following issues of AGRICULTURAL ENGINEERING: Ground Water, October, 1946, page 474; Water-Plant-Soil Relationships, December, 1946, page 572, and Runoff, January, 1947, page 29.

One of the first things your committee did was to investigate the possibility of publishing a yearbook on hydrology. Need for bringing together the important papers on agricultural hydrology and related fields in one volume is obvious to all of us. A companion project is the issuing of an illustrated publication on equipment, instruments, and devices which prove useful in agricultural hydrology. The prospects of getting this done are better than one might think. However, it calls for a good deal of work to make this dream a reality.

The Committee's effort toward developing a curriculum in agricultural hydrology is an important activity. No real progress can be made in insuring proper use of hydrologic principles in agriculture until agricultural hydrology becomes part of the curriculum of our colleges. Through the efforts of R. B. Hickok, Ivan D. Wood, and the Committee, agricultural hydrology was discussed at the A.S.A.E.-sponsored teaching seminar at Purdue University in 1946. This discussion and inquiries from some of the colleges resulted in a suggestion from the chairman of the Soil and Water Division that the Committee take definite steps toward developing outlines for courses in agricultural hydrology. We obtained suggestions from leading members of the profession and are now ready to bring this matter before the College Division for further action. It is proposed to set up a joint committee which will carry this important project to completion.

As is customary, the Committee was asked to suggest papers for the 1946 A.S.A.E. Annual Meeting. The paper, titled "Precipitation-Evaporation Indices and Their Use in Estimating Crop Yields for Potential Irrigation Projects," was presented by Wendell C. Munson. Another paper, "Rates of Runoff from Small Drainage Basins," by D. B. Krimgold, published in AGRICULTURAL ENGINEERING for January, 1947 (pp. 25-28), and a round-table discussion of courses in agricultural hydrology completed our contribution to the meeting.

This year the Committee assumed responsibility for the program for two sessions of the annual meeting, which also included contributions of the Committee on Agricultural Meteorology.

A report of the A.S.A.E. Committee on Agricultural Hydrology and its subcommittees on runoff, watershed studies, water-plant-soil relationships, ground water, and evaporation from water surfaces, presented at the annual meeting of the American Society of Agricultural Engineers, at Philadelphia, Pa., as a contribution of the Soil and Water Division.

ACKNOWLEDGMENT: The Committee on Agricultural Hydrology wishes to express its appreciation for the encouragement and help of the following persons: To Dr. M. L. Nichols, A.S.A.E. president, 1946-47; to Ivan D. Wood and Howard Matson, respectively, chairman of the Soil and Water Division in 1945-46 and 1946-47; to Dr. R. W. Trullinger in connection with formulating the scope, objectives, and activities of the Committee; to Dr. R. E. Moore for participation in formulating the program of the Subcommittees on Water-Plant-Soil Relationships; to Dr. O. E. Meinzer for collaboration in the work of the Subcommittee on Ground Water, and to C. S. Slater for directing the work of the Subcommittee on Water-Plant-Soil Relationships.

Report of the Subcommittee on Runoff

By D. B. Krimgold, Chairman

THE scope, objectives and plans of the Subcommittee were outlined in the article, entitled "Runoff as a Phase of Agricultural Hydrology," in AGRICULTURAL ENGINEERING for January, 1947 (p. 29). In this paper runoff is treated under three main headings — rates, amounts, and effect of land use and conservation practices. This subdivision was used, not because rates are independent of amounts or because the effects of land use involve different factors, but because, in the application to engineering problems, each of the three subjects is dealt with more or less independently. Thus rates of runoff from watersheds of various characteristics are the principal concern in the design of spillways, culverts, and ditches; amounts, on the other hand, are given sole consideration in determining the adequacy of a watershed as a source of water

supply. In flood control investigations, the effect of land use and of conservation practices on both rates and amounts are the major, if not the only, concern.

The first paper of what it is hoped will result in a symposium on rates of runoff was presented at the 1946 A.S.A.E. annual meeting, and was published in AGRICULTURAL ENGINEERING for January, 1947 (p. 25). This paper — "Rates of Runoff from Small Darinage Basins" — discusses the factors affecting rates of runoff from small natural watersheds in relation to some preconceived ideas on the rainfall runoff relationship. It also contains an outline of a new approach, resulting from a study of numerous records which became available in recent years. The new approach involves five steps, each of which merits one or more papers. The paper "Analysis of Runoff," by W. D. Potter, is in effect an application of some of these steps in the determination of effects of land use on rates of runoff.

At the request of the Highway Board, the chairman of your Subcommittee presented a paper before the 26th annual meeting of the Board. This paper, entitled "On the Hydrology of Culverts," pointed out the similarity of the problems in highway drainage and in soil and water conservation. It summarized the results of runoff studies conducted over a period of about eight years and showed how, with the approach outlined in the previous paper, these results were made available for use in design, and how the new approach makes possible the collection of additional records with a small fraction of the expense and effort previously spent in this work. Of the several publications on runoff, in which the new approach or a modification of it was followed, two have been completed. "Rates of Runoff in the Coastal Plains of New Jersey, Delaware, and Maryland," SCS-TP-60, is about to be issued. The other publication, "Hydrologic Design of Farm Ponds and Rates of Runoff for Design of Conservation Structures in the North Appalachian Region," SCS-TP-63, is ready for printing and will be issued as soon as 1948 funds become available. An earlier publication in the same series, SCS-TP-56, contains similar information for the Claypan Prairies.

Other more or less recent contributions on runoff of interest to agricultural engineers include:

"Flow from Drainage Basins Determined by Short-Term Records," by L. L. Harrold (Preceedings, American Society of Civil Engineers, April, 1945); "Runoff-Behavior of Small Agricultural Watersheds Under Various Land Use Practices," by H. W. Hobbs (Transactions, American Geophysical Union, February, 1946); "Application of Stream Gaging to the Agricultural Use of Small Streams and Ponds," by M. T. Thomson (AGRICULTURAL ENGINEERING, January, 1946); "The Effect of Conservation Practices on Peak Rates of Runoff," by Ralph W. Baird (Texas Engineer, August, 1946); "Agricultural Engineering Problems in Watershed Planning," by A. W. Zingg (AGRICULTURAL ENGINEERING, Sept. 1946), and "Flood Abatement by Headwater Measures," by Howard L. Cook (Civil Engineering, March, 1945).

Report of Subcommittee on Watershed Studies

By L. L. Kelly, Chairman

AN inventory of small watershed investigations was begun in 1942. Questionnaires were sent out to all agencies, colleges, etc., that it was thought might have small watershed investigations in operation. Because of the war work on the inventory was discontinued shortly after replies to the questionnaires were received.

Work was resumed again in 1946. The aid of a man in each region of the USDA Soil Conservation Service was enlisted. These men are: Region I, Harold W. Hobbs, Region II, J. R. Carreker, Region III, John S. Glass, Region IV, Vilas Young, Region V, L. L. Kelly, Region VI, J. H. Dorroh, and Region VII, A. L. Sharp.

We have or are in the process of checking, with the various agencies, colleges, etc., questionnaires submitted in 1942.

The questionnaires cover the following information for each small watershed: Location; size; drainage density; slope; cover; culture; depth, type, texture, and permeability of soils; instrumentation; purpose for which investigation is being made, and type of data compiled and published.

The recommendations of the members of the Society concerning the final compilation and presentation of this information are invited. It is believed that the inventory, compilation, and report should be completed in six months.

Report of Subcommittee on Water-Plant-Soil Relationships

By C. S. Slater, Chairman

THE work of the Subcommittee began with the preparation by its chairman of a tentative outline for committee action. Copies of the tentative outline were sent out for criticism and discussion. The suggestions so received were helpful in formulating a working plan for the Subcommittee and in delineating its scope and objectives. These were outlined in "Plans of the Subcommittee on Water-Plant-Soil Relationships," published in AGRICULTURAL ENGINEERING for December, 1946.

It is stated in the published plans that first efforts should be directed toward a condensation of known information on subjects within the scope of the Subcommittee. A start has been made in this direction in the paper, entitled "On the Flow of Water Through Soils." It is hoped that further synoptic papers will be forthcoming in other of the many phases of pater-plant-soil relationships.

Report of Subcommittee on Ground Water

By W. D. Potter, Chairman

FOLLOWING the lead of our parent committee, the Subcommittee on Ground Water proposed a series of symposia, the objective being to explore the possibilities for a more extensive and intelligent use of ground water in agriculture.

In collaboration with Dr. O. E. Meinzer, then geologist in charge of the division of ground water, U.S. Geological Survey, a concise statement of the scope and plan of action of the Subcommittee was developed and the titles selected for the series of symposia. At Dr. Meinzer's suggestion a copy of this statement together with an invitation to participate in the first symposium were sent to eight of the leading geologists engaged in ground water studies in various parts of the country. Copies of this statement of objectives were also sent from time to time to other individuals who it was thought might be interested in the Subcommittee's program.

The subject selected for the first symposium was: "What facts should be known about farm ground-water supplies, and how can that information best be obtained?" Through the paper submitted for this symposium, the Subcommittee hoped to secure information from various parts of the country as to what steps are being taken to furnish answers to such questions as: How deep would I have to drill to secure a ground water supply for stock water or supplemental irrigation? About how much would it cost? How much water would such a well furnish? How dependable would be the supply? It was hoped that each contributor would discuss the present setup for furnishing this type of information, pointing out its shortcomings and recommending improvements. Finally it was planned to make the symposium question a topic for national and sectional round-table discussions with the hope that these discussions would lead to the adoption of definite recommendations.

In response to the request for papers dealing with the first symposium question, the following papers have been received and published in AGRICULTURAL ENGINEERING:

"Ground Water for Agriculture in Missouri," by John Grohskopf and K. E. Anderson (October, 1946, p. 465). "Ground Water in Utah," by Ed. H. Watson (November, 1946, p. 518). A letter explaining the ground water setup in Nebraska, from Dr. G. E. Condra (February, 1947, p. 67). "Ground Water for Irrigation in Georgia," by S. M. Herrick (November, 1945, p. 521). "A State Ground Water Code (Washington)," by Rodney Ryker (December, 1946, p. 571). "Ground Water in California," by C. N. Johnson (March, 1947, p. 99). "Water Spreading as a Means of Ground Water Replenishment," by Dean C. Muckel (February, 1948, p. 74).

Although the response to the symposium idea was short of the Subcommittee's expectations, we have promises for at least two additional papers and still plan to make the symposium question the topic of round-table discussions.

Report of the Subcommittee on Evaporation

By T. W. Edminster, Chairman

IT is the purpose of the Committee on Agricultural Hydrology to encourage activity in a hitherto largely neglected field of agricultural engineering. With this development, evaporation becomes a necessary subject for investigation.

During recent years agricultural engineers have become increasingly interested in problems of water storage, such as farm stock and fish ponds, small reservoirs for irrigation purposes, etc. Such ponds and reservoirs are an integral part of the program for proper land utilization, using waste areas and supplying water to areas otherwise without it. These ponds are making possible valuable land-use changes in the interest of soil conservation.

Each structure contributes both design and maintenance problems which require a definite knowledge of the evaporation factor for each specific area in which they are located. In commenting on the sources of data in the Claypan Prairies hydrology report, Krimgold and Minshall* say, "The runoff and evaporation records are far too meager to permit the complete analysis on which to base final recommendations for design". In the foreword to this same publication, Dr. M. L. Nichols makes this comment: "Field studies of evaporation from small reservoirs must be conducted to verify the values used in this report."

In the arid regions of the United States evaporation records have been maintained rather extensively for the benefit of those engaged in irrigation. But in the humid regions such records have been rather meager. However, as supplementary irrigation through the use of portable pipe systems and other low cost methods has extended into the humid regions, such data are now urgently needed. For example, Virginia's only source of evaporation data prior to the establishment of equipment by the Soil Conservation Service in Blacksburg were records from Chapel Hill, North Carolina, and Wardensville, West Virginia. Neither location was fully representative of any extensive area or conditions encountered in Virginia.

It is of paramount importance that definite and immediate steps be taken to delineate the needs in evaporation data and to work out and support a program with which to meet these needs. To accomplish these ends, the Subcommittee on Evaporation from Water Surfaces proposes the following program:

A Evaluation of the information needed
- 1 Develop through an intercommittee and society membership canvas a list of specific agricultural uses and applications of evaporation data
  - (a) Form of presentation needed, i.e., daily, monthly, seasonal or annual values, pan vs. theoretical, etc.
  - (b) Tolerances of accuracy acceptable for each specific use
  - (c) To be of greatest value, how best should these data be presented?

B Evaluation of the information available
- 1 Development of an annotated bibliography covering the phases of evaporation most applicable in agricultural engineering
- 2 Preparation of a list of all available sources of evaporation data
  - (a) Prepare a map showing locations of evaporation stations
    - (1) U. S. Weather Bureau
    - (2) Other agencies, i.e., Soil Conservation Service, Bureau of Plant Industry, Soils and Agricultural Engineering, etc.
    - (3) Private and corporation maintained
  - (b) Summarize in tabular form the characteristics of these stations, i.e., exact location, type of equipment, period of operation, status of records, availbility of records, etc.
  - (c) Prepare a fully referenced summary of the more widely known and used methods of theoretical computation
- 3 Analyze existing methods of evaporation data presentation and release as they relate to agricultural hydrology.

C Determine and take steps to overcome the weaknesses in the existing information on evaporation as it applies to agricultural hydrology
- 1 Develop ways and means to supplement these weaknesses
  - (a) Assist in getting these measures into practice
- 2 Encourage and promote programs of research on the problem of evaporation as it applies to agriculture
  - (a) Assist in the coordination of such research programs.

D Encourage and promote active consideration and study of the problems on the part of agricultural engineers
- 1 Conduct symposia dealing with the most critical issues
- 2 Hold joint discussions of the problem with other committees of the A.S.A.E and with similar committees of the other engineering societies, such as A.S.C.E. and the Hydrology Section of the U.S.G.S.

The foregoing outline may serve as a nucleus for the activity of the subcommittee during the first year of its activity. As experience dictates the need, this outline will be revised to more fully cope with the problem.

In the meantime, in order to stimulate active thinking along the lines of evaporation problems in agricultural hydrology, the following subjects are suggested as possible themes for future symposia:

1 What are the present-day sources of evaporation data?
2 What limits of accuracy are required of evaporation data for agricultural hydrology purposes?
3 In the absence of past evaporation records, what is the agricultural hydrologists' next recourse?
4 How may the evaporation station network be enlarged and improved?
5 Are the present methods and techniques that are used for determining evaporation adequately suited to agricultural needs?

*D. B. Krimgold and N. E. Minshall, Division of Drainage and Water Control Hydrologic Design of Farm Ponds and Rates of Runoff for design of Conservation Structures in the Claypan Prairies.

Heating by Refrigeration

(Continued from page 204)

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Some 1947 Results of Barn Hay Drying Research

By C. W. Terry
MEMBER A.S.A.E.

COST OF OPERATING MOW CURING SYSTEMS [1]

COSTS of mow hay drying were investigated on 27 New York farms. Although there were several different types and sizes of units, the average figures give a reasonably good analysis of the cost for the particular season. It was noted in the original report that the rainfall was less than normal; therefore the costs, particularly that for power, are correspondingly low.

The largest item of expense was depreciation, representing more than one-third of the total cost of operation. Power cost was the second largest item, slightly less than one-third of the total. Repairs represented a minor expense.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Farm Structures and Rural Electric Divisions.

C. W. TERRY is professor of agricultural engineering, Cornell University, Ithaca, N. Y.

[1] From a thesis by L. H. Davis, department of agricultural economics, Cornell University. Data were secured in cooperation with the state Farm Electrification Council.

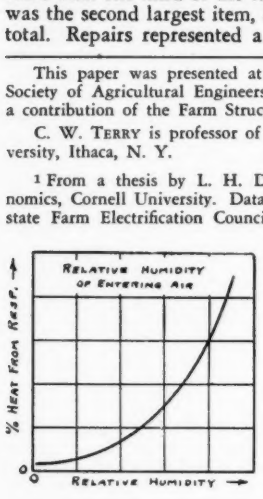


Fig. 1 (*Upper Left*), Fig. 2 (*Upper Right*), Fig. 3 (*Lower Left*), and Fig. 4 (*Lower Right*) Effect of different variables on the per cent of heat supplied by respiration

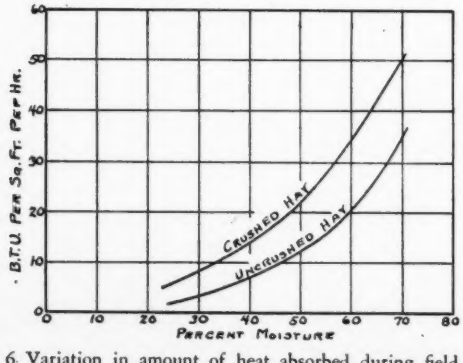


Fig. 6 Variation in amount of heat absorbed during field curing of hay

Costs were as follows:

	Annual costs	Costs per ton	Per cent
Depreciation	$37.72	$0.63	37.1
Power	31.58	0.53	31.0
Interest	21.63	0.36	21.3
Housing	6.00	0.10	5.9
Repairs	3.08	0.05	3.0
Insurance	1.73	0.03	1.7
Totals	$101.74	$1.70	100.0

VARIATION IN HEAT OF RESPIRATION

Tests were made to arrive at a more complete analysis of the heat of respiration. This has been the subject of consider-

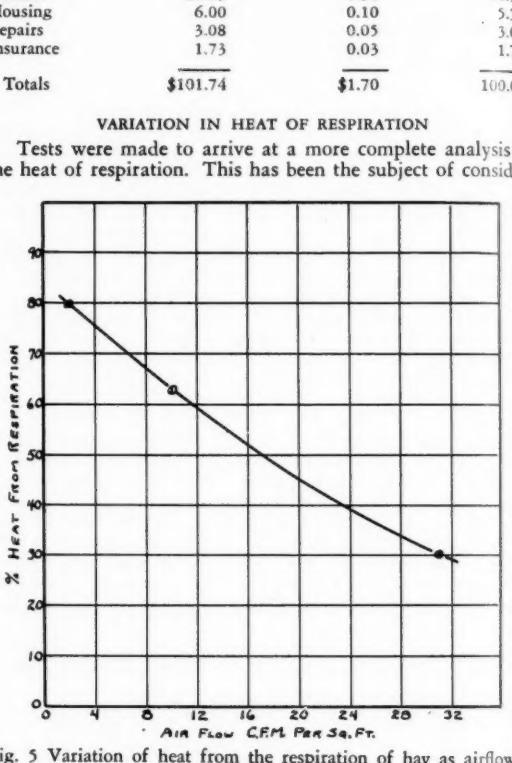


Fig. 5 Variation of heat from the respiration of hay as airflow is varied (test results)

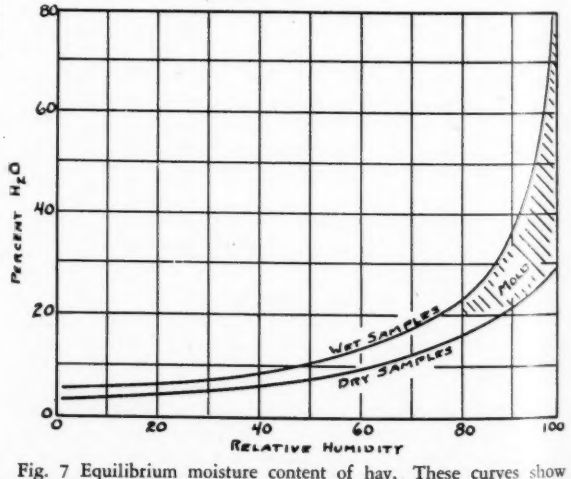


Fig. 7 Equilibrium moisture content of hay. These curves show how the moisture content of hay varies with relative humidity of the environment air. The upper curve is for hay the moisture content of which was high and is being reduced. The lower curve is for hay that has been dried with heat or some drying agent such as silica gel, and is being rehydrated

able discussion and investigation. Before making any tests, calculations were made to ascertain the probable effects of several variable factors. Four of these are illustrated by the curves in Figs. 1 to 4. In any actual cases these and other factors may occur in a wide variety of combinations thus making it difficult to predict just how much heat will be supplied from this source.

Variable air flow was checked experimentally with bin tests. Three bins were filled with hay from the same load. Air flow rates of 1.8, 10, and 31 cfm per sq ft were used. Temperature and relative humidity of the entering and exit air were recorded as well as the total weight loss. The amount of heat supplied by the air and the corresponding quantity of water evaporated were calculated by use of the psychrometric chart. The difference between calculated and actual weight loss was assumed to be due to respiration. The test results are shown graphically in Fig. 5. This corresponds very closely to the predicted curve Fig. 2.

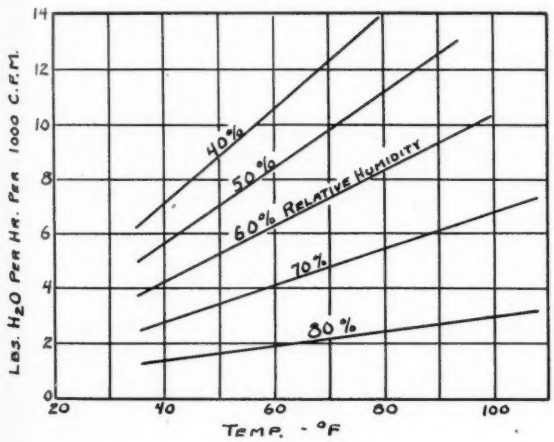
The curves and test results indicate that in some cases very little, and in others practically all of the heat for evaporation of moisture from hay, may be supplied by the respiration process. With high relative humidity, moderate temperature, and low air flow, internal heating is responsible for most of the evaporation. On the other hand, high temperature, low relative humidity, and a large air flow dry the hay quickly and greatly reduce the amount of heat from respiration.

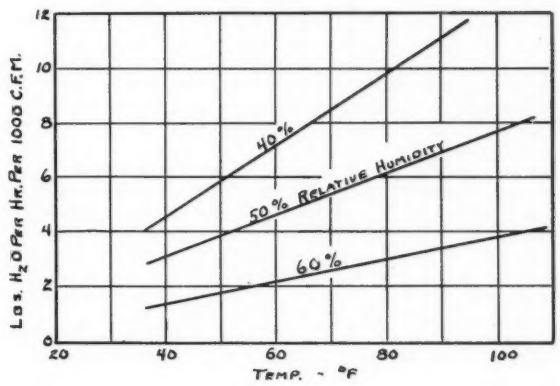
THE MOWER-CRUSHER

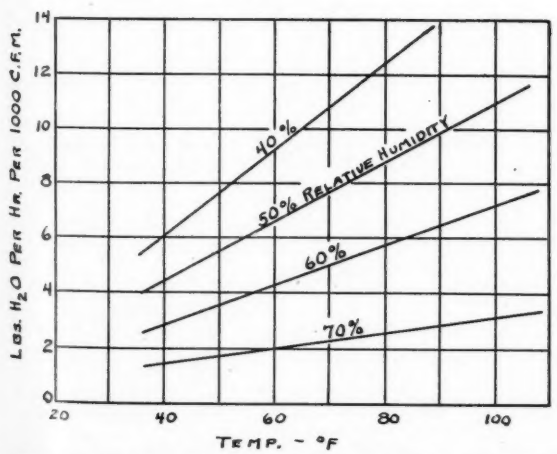
Although not strictly a part of mow curing, it seems that the crusher-mower has not received attention in proportion to the results it accomplishes. This machine was first tried several years ago[2]. To a great extent economic factors are probably responsible for its lack of general acceptance.

Comparative drying rates for hay in the swath, with and without crushing, have been determined in field tests at Cornell by H. B. Hartwig and others. Data from these tests have been transposed into a form which illustrates quite clearly the effect of crushing (Fig. 6). Since moisture is evaporated only as heat is supplied from some source, the number of Btu required for this evaporation is used as one of the coordinates for plotting the curves. Per cent moisture in the hay is the other co-ordinate. The curves show that absorption of heat by the crushed hay is more rapid than in the case of the uncrushed hay. This was true practically without exception for all the tests made. The explanation for this lies in the fact that water gets to the surface of the crushed stems more easily and quickly. More uniform drying is obtained and better quality hay results. The hay may be put in the barn several hours, sometimes a day or two, sooner than where the crusher is not used. *(Continued on page 214)*

[2] Preliminary trials of a new type of mower, by Roy Bainer, AGRICULTURAL ENGINEERING, May, 1931—pp. 165-166; and The Mower-Crusher in Hay Making, by Frank J. Zink, AGRICULTURAL ENGINEERING, March, 1933, pp. 71-73.







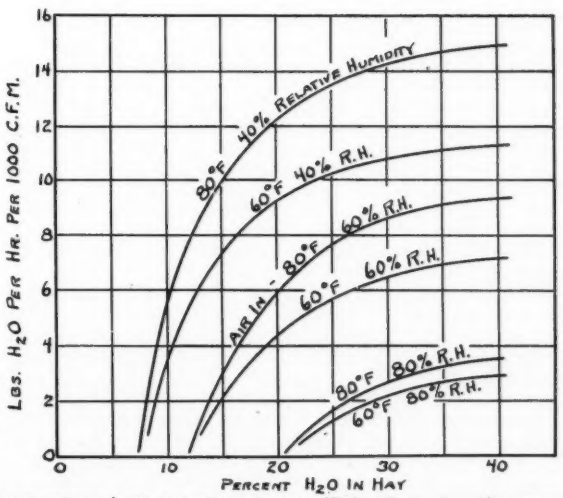


Fig. 8 (*Upper Left*) Rate of removal of water from hay whose moisture content is 25 per cent or more. (Exit relative humidity = 90 per cent) • Fig. 9 (*Lower Left*) Rate of removal of water from hay whose moisture content is about 20 per cent. (Exit relative humidity = 80 per cent) • Fig. 10 (*Upper Right*) Rate of removal of water from hay whose moisture content is about 15 per cent (Exit relative humidity = 70 per cent) • Fig. 11 (*Lower Right*) Variation in rate of moisture removal from hay as its moisture content decreases for different entering air conditions

The Mechanics of Small Earth Dams

By Ralph B. Peck

DURING the past twenty years, there has been a rapid development in the application of soil mechanics to large earth dams. These developments have taken place along three principal lines, namely (1) an improved ability to cope with foundation problems, (2) improved methods for classifying embankment materials and determining their suitability for the construction of dams, and (3) improved methods for control of the placement of earth embankments.

On many projects, large sums of money have been justifiably spent in the investigation of subsoil conditions and the determination of the physical properties of embankment materials. These expenditures have resulted in increased safety of earth dams and at the same time in the more economical use of available materials. However, the thorough and costly studies appropriate for large dams can hardly be afforded in connection with small ones less than 40 or 50 ft high. In spite of this fact, certain principles are applicable to structures of any size, and it is the purpose of this discussion to consider a few aspects of small dam construction wherein soil mechanics is useful.

In most of the literature concerning earth dams, attention is given primarily to the fill itself. This is especially true of the literature of small dams. Very little has been written about the importance of foundation conditions or means for improving unsatisfactory conditions. Yet a study of the causes of failure of earth dams leads to the conclusion that defects in the foundation are responsible for more failures than any other cause except overtopping. Failures due to defects in the embankment itself are very rare indeed.

The foundation for an earth dam should satisfy two independent conditions. In the first place, its hydraulic characteristics should be satisfactory. That is, it should be sufficiently watertight to prevent excessive leakage beneath the dam, and it should be safe against failure by piping. In the second place, it should have adequate strength to eliminate the possibility of a failure under the weight of the overlying fill or under the influence of the water pressure.

If the foundation material consists of sand or gravel or contains layers of these materials, leakage out of the reservoir may be excessive. This fact is commonly recognized and attempts to cut off the water are often made by constructing more or less impervious membranes beneath the dam. Such cutoffs do not always accomplish their purpose for a variety of reasons. In the first place, many reservoir sites are bounded by pervious deposits through which appreciable leakage can take place when the water level is raised. Even if the dam and its foundation are practically watertight, leakage through an adjacent hillside may render the reservoir useless. A second source of leakage is more or less horizontal flow around the ends of an earth dam unless the cutoff wall goes far into the abutments. Inasmuch as water can flow readily through even a thin horizontal layer of high permeability, failure to cut off one such layer around the end of the dam may be more serious than neglect of the entire flow beneath the embankment itself.

Flow beneath the base of the dam can be reduced by several methods. If an impervious rigid material such as sound bedrock is located at a shallow depth beneath sand and gravel, it may be convenient to construct a reinforced concrete cutoff wall as shown in Fig. 1a. However, consideration should always be given to the fact that most bedrock is far from impervious because natural rock formations contain bedding planes, solution channels, joints, and other natural defects. Hence, the construction of a complete cutoff represents an ideal that cannot always be attained at reasonable expense. Steel sheet piles are often used as complete cutoffs. However, the permeability of a steel sheet pile wall is likely to be at least as great as that of a fine sand. Furthermore, it is commonly impracticable to establish a seal between the bottom of the sheet piles and the bedrock. Therefore, steel sheet pile cutoffs are of doubtful value in fine sand or silt or in deposits where the bedrock surface is irregular or fissured.

A reinforced concrete cutoff wall might be appropriate under the conditions shown in Fig. 1a because the bedrock is relatively unyielding and the settlement of the core wall under the weight of the fill would be small. On the other hand, under the conditions shown in Fig. 1b, the impervious clay beneath the sand and gravel might deform to a considerable extent under the weight of the fill. Such a deformation would tend to crack the concrete and make a concrete cutoff wall ineffective. Under these circumstances, a cutoff of clay rolled or puddled in place would be more suitable.

It seems likely that too much attention has been given in the past to complete cutoffs. In many small reservoirs, there is no objection to a reasonable seepage loss provided the escape of the water does not weaken the dam. It may be worth while in many instances to consider the advisability of a partial cutoff.

One of the possible arrangements for the foundation of a small earth dam is shown in Fig. 1c. Here it is assumed that the subsoil consists entirely of sand and gravel that becomes somewhat coarser with depth. This is a fairly common situation. The large depth to impervious material or perhaps the presence of large boulders in the deposit would make a complete cutoff impracticable. The relatively fine sand above the coarser material is beneficial in that it tends to separate the extremely pervious layers from the water in the reservoir. Further resistance to flow can be developed by constructing an impervious upstream blanket to reduce the seepage to a tolerable amount. A simple computation can be made to indicate the order of magnitude of the probable seepage losses.

If a blanket is used instead of a cutoff wall, a filter must be constructed in the base of the downstream portion of the embankment. The filter consists of material somewhat coarser than the sand upon which it rests. It may be built up of two layers, of which the uppermost is very coarse. Water seeping through the sand beneath the dam enters the filter where its energy is immediately dissipated because the coarse layers of the filter offer practically no resistance to flow. Yet the inflowing water does not wash any fines from the sand into the filter because the grain size of the filter material is chosen according to specifications designed to prevent such migration. Therefore, the filter eliminates the possibility of the formation of springs beneath the area which it covers, and prevents the consequent development of erosion tunnels that may lead to failure by piping. Furthermore, it prevents the softening of the downstream toe of the embankment. The use

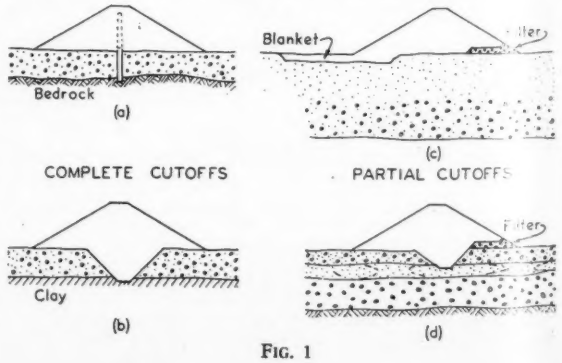


FIG. 1

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Soil and Water Division.

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of filters has become commonplace in the construction of large dams. Their stability and effectiveness have been amply demonstrated and they deserve more consideration in connection with small structures.

Fig. 1d shows a somewhat more complex foundation condition. Here a relatively fine layer rests above an extremely coarse layer and beneath a moderately coarse layer. It might be impracticable or impossible to make a tight cutoff. If so, it might be preferable to allow leakage to take place through the bottom extremely coarse layer: This layer would be fairly well insulated from the bottom of the reservoir by the fine layer above it. The cutoff would then merely extend through the upper layer and the filter would eliminate the danger of piping from whatever water flowed beneath the cutoff trench.

This figure also demonstrates the uncertainties that always exist in connection with the design of dam foundations. If instead of a continuous layer of fine sand, there were lenses surrounded by coarse material, as indicated by the dash lines, it is obvious that the shallow cutoff would be entirely ineffective. Water could pass around the lens in which the cutoff was buried, and leakage would be very greatly increased. However, the dam would still be safe against failure by piping if the filter were adequately designed and if provisions were made to extend the filter downstream over any areas where springs might develop. The leakage would be greater than anticipated but it could be reduced by some expedient such as the application of a bentonite seal on the floor of the reservoir. It is quite conceivable that a dam of this type, even if subsequent remedial measures should be found necessary, might be cheaper than one containing the more conventional types of cutoff construction.

It should be emphasized that no reasonable amount of soil exploration could establish whether the fine sand was a layer or merely a series of lenses. Yet this factor would be decisive in connection with the behavior of the dam. Hence, the designer must always be prepared for the worst possible conditions, should they materialize, even if he designs the dam on the basis of conditions that appear to be more probable.

The preceding discussion is not intended to imply any definite recommendations concerning the cutoff of water in foundations. It merely indicates that a variety of solutions is possible and that a careful study of the subsoil conditions and their implications may make it possible to exploit the advantages of a given foundation at low expense.

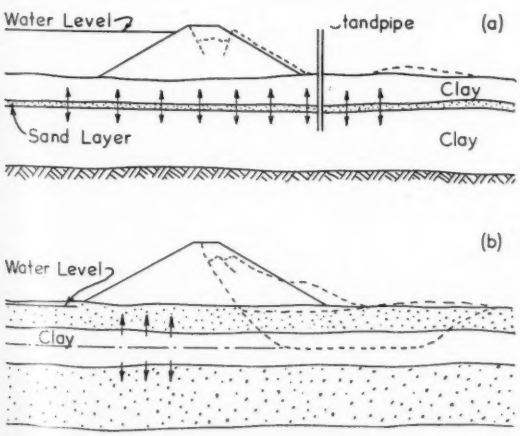
We may now consider briefly the outright failure of the soil beneath an embankment. Fig. 2a shows a small dam resting on a layer of compressible clay. If the clay does not contain any layers of sand, the foundation material is unlikely to fail unless it does so during the construction period. Very simple soil tests provide all the information necessary to determine the factor of safety against such a failure. A similar failure would occur if the clay layer were comparatively thin, as shown in Fig. 2b. Under the weight of the fill, water would squeeze out of the clay and into the sand layers above and below, and the clay would become stiffer near its boundaries. It would be weakest along its centerline and the failure would occur along a surface of sliding that remained as long as possible within the clay layer.

Failures of the type described in the preceding paragraph are not catastrophic. Since they are preceded by noticeable deformations, they can be foreseen and hence prevented by establishing and observing simple reference points. On the other hand, if the clay layer contains even one thin layer of sand, as shown in Fig. 2a, an entirely different type of failure may occur either during construction or during the first filling of the reservoir. Under the weight of the embankment, water is squeezed out of the clay into the sand layer in which it can flow readily in a horizontal direction. The pressure of the water in the sand layer tends to lift the body of clay above it. Just below the downstream toe of the dam, where the weight of the overburden is least, the clay may behave as if it rests upon a completely frictionless base and may slide for a long distance without giving previous warning in the form of noticeable deformations. Such failures may be truly catastrophic.

The presence or absence of a sand layer that might lead to a failure of this type cannot be determined by any reasonable amount of soil exploration. Therefore, no elaborate theoretical study of stability is justified. Yet, the presence of dangerous water pressures can be ascertained by means of water pressure devices or standpipes. Observations on such devices during and for a short period after construction eliminate all danger of an unexpected failure of this type. By means of such observations, a more accurate conception of the subsoil conditions can be obtained than by means of elaborate soil sampling and testing.

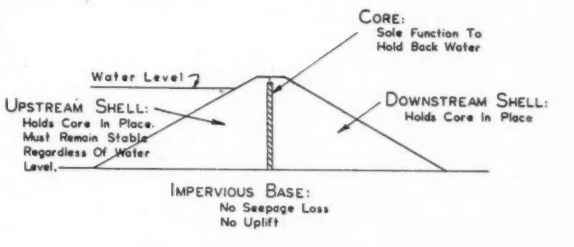
The preceding comments again illustrate the uncertainties inevitably associated with dam foundations. They emphasize the necessity for planning and making field observations during and after construction in order to ascertain the actual degree of safety of the structure. Without such observations, the safety of any earth dam should be considered suspect. By means of the observations, the factor of safety can be evaluated with accuracy even in the face of a limited amount of preliminary subsoil information.

My final remarks are concerned with the design of the embankment itself. Again the remarks *(Continued on page 214)*

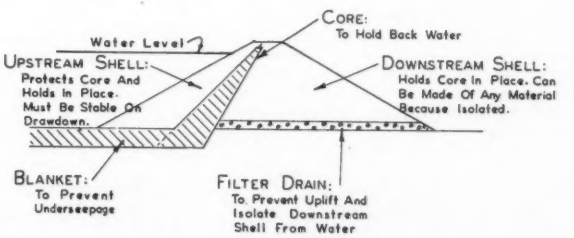


FOUNDATION FAILURES

FIG. 2



(a) IDEAL DAM - CONVENTIONAL SECTION



(b) FUNCTIONAL LAYOUT OF EARTH DAM

FIG. 3

Rainfall-Runoff Relationships for Small Watersheds

By Vilas D. Young
ASSOCIATE A.S.A.E.

IN ANY study of the rates and amounts of runoff from small or large drainage basins it is first necessary to formulate an hypothesis upon which to work and then attempt to arrive at the laws which govern this complex phenomenon. There are numerous factors and interrelationships of factors which enter into the problem, very few of which will remain constant. There have been a number of empirical formulas developed by engineers for determining rates and amounts of runoff. Upon examination, these reveal that many were developed for specific localities and are applicable only under specified conditions. A brief review of literature pertaining to the runoff problem and to the scope of studies directed towards a solution was presented before the American Society of Agricultural Engineers in 1938 by Krimgold[1].

In order to meet a need for quantitative data on the effects of soil and water conservation practices on erosion and runoff for upstream engineering, runoff investigations were started in Region 4 by the Soil Conservation Service in 1938 and 1939. These runoff studies are being conducted by the Divisions of Operations and Research of the SCS in cooperation with the respective state agricultural experiment stations. Three groups of these studies were planned. Each group falls within a basic land resource area, and each is situated on predominant soil types and slopes of that basic land area. The soil profiles of these groups vary from a slowly permeable soil, as found in the Blacklands of Texas, to a freely permeable soil as found in the Ozark Highlands of northern Arkansas and southern Missouri. The drainage areas of the watersheds are small. They range in size from 9.3 to 25.0 acres, with the exception of the two largest which are 65.4 acres and 97.0 acres, respectively.

Detailed surveys have been made of the watersheds selected and soil and topographic maps completed. These records show the permanent characteristics, such as length and degree of slope, drainage pattern, configuration of surface, drainage density, slope lengths, size and shape of the watersheds. They also show conservation improvements such as terraces and structures. The detailed soil survey shows texture, structure, soil class, and depths of the soil horizons as well as permanent vegetal covers. Records are being maintained of the variable influences such as precipitation, runoff, temperature and humidity, degree, condition and kind of cover, tillage practices used, and dates of change in cropping practice. Much valuable information has been collected. These records are being compiled, analyzed, and prepared for publication as time and personnel permit. A method of compilation has been developed which will permit the widest possible use of these data and contribute to the science of hydrology. It must be realized that the period of record for these watersheds is too short to arrive at reliable estimates of rates and amounts of runoff for 10, 25, or 50-year frequencies; also, that the results of an analysis at this time are approximate tentative values. These of necessity will be subject to revision in the light of future records.

For the purpose of discussion a brief review will be made of the procedures being used in making an analysis.

Peak Rates of Runoff. In calculating approximate values of peak rates of runoff two methods are being used, both of which are subject to limitations. One is the "rational" method while the other is that of "recurrence intervals." In using the rational method, hydrographs are plotted of both the rainfall and the runoff, and the time of concentration is determined for each individual storm and watershed. Using this time, the average rainfall intensity is determined for the period of concentration. Then this intensity and the maximum peak rate of runoff are substituted in the formula, $Q=CIA$, and the equation solved for the value of C. The time of concentration has been found to vary considerably for different storms and the coefficient C to have a wide range of values. With the rational method, the 10, 25, or 50-year peak-rate values are obtained by applying the value of coefficient C to 10, 25, or 50-year values of rainfall intensity as obtained from USDA Miscellaneous Publication No. 204 (Yarnell)[2] for the time of concentration, and solving the equation for the value of Q.

In using the recurrence-interval method, the maximum peak rates for individual storms for the period of record are arranged in descending order of magnitude. These data are then plotted on logarithmic and logarithmic probability coordinates to determine the 10, 25, and 50-year probable rates. The plotting position or recurrence interval of each of the listed peak rates is computed by the formula $P=T/N$, where P equals the recurrence interval in years, T the number of years of record, and N the order number. With seven years of record the recurrence interval P of the highest value ($N=1$) will be 7, while for the 10th value ($N=10$) it will be 0.7. For the period of record the highest peak-rate value has occurred but once while the second highest has been equaled or exceeded twice. After plotting these values a curve is drawn which best fits the points, and this curve extended to deter-

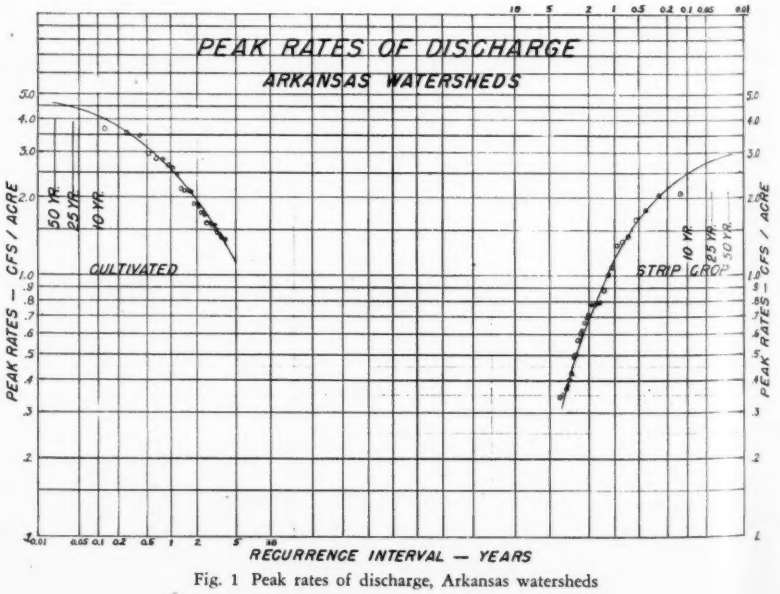


Fig. 1 Peak rates of discharge, Arkansas watersheds

This paper was presented at a meeting of the Southwest Section of the American Society of Agricultural Engineers at Texarkana, Texas, April 4, 1947. Authorized by the Director, Arkansas Agricultural Experiment Station, for publication as Research Paper No. —, Journal Series.

VILAS D. YOUNG is agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture.

[1]Krimgold, D. B. Runoff from Small Drainage Areas. AGRICULTURAL ENGINEERING, vol. 19, no. 10, October, 1938.

[2]D. L. Yarnell. Rainfall Intensity-Frequency Data. USDA Misc. Pub. No. 204, 1935.

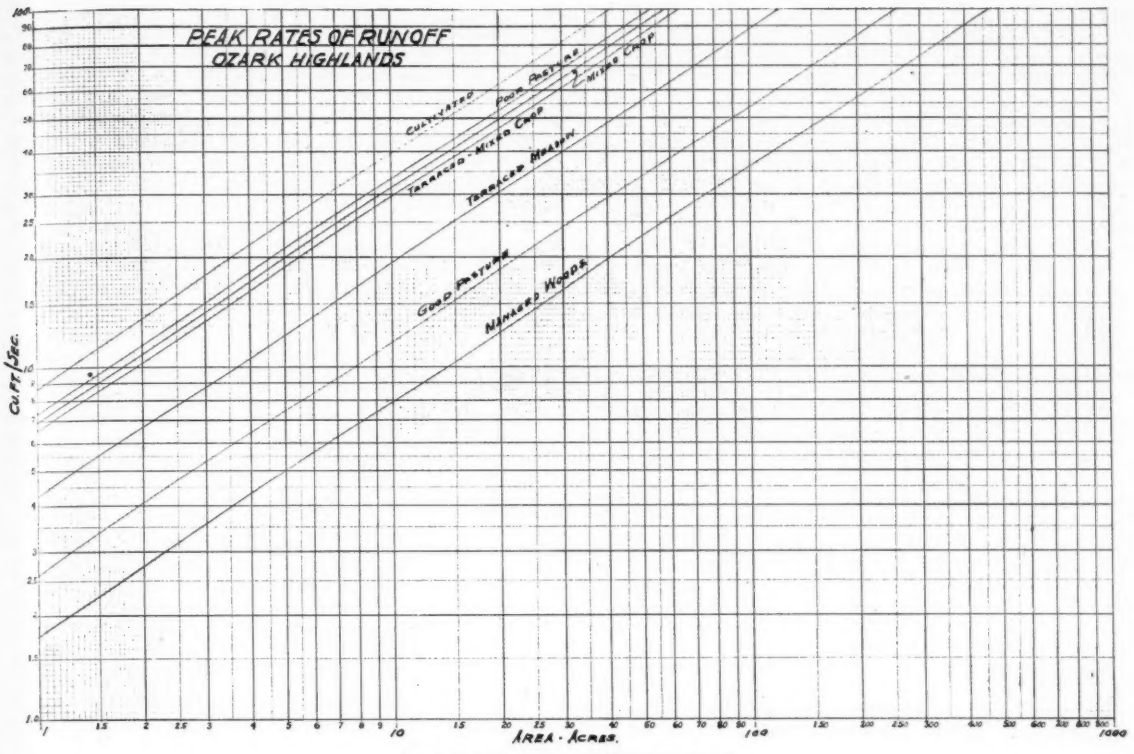


Fig. 2 Peak rates of runoff, Ozark Highlands

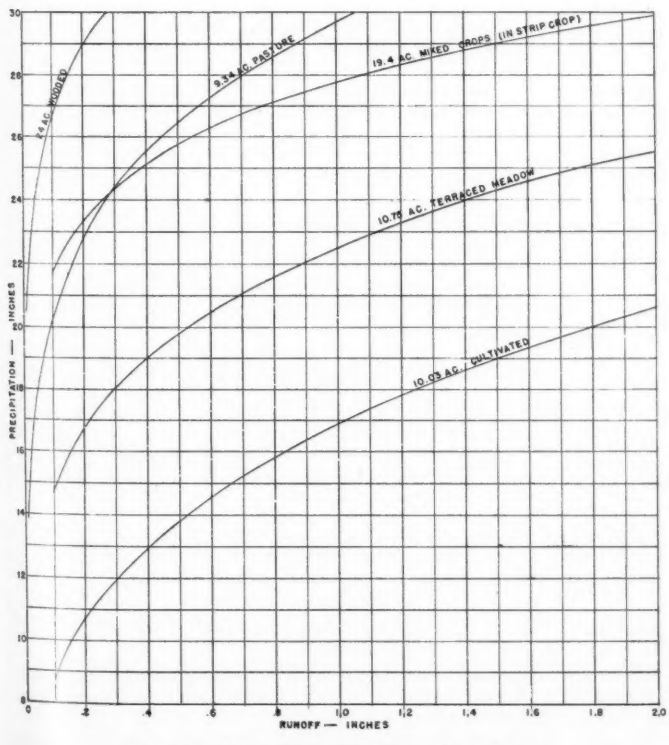

9.34 AC. PASTURE
19.4 AC. MIXED CROPS (IN STRIP CROP)
10.78 AC. TERRACED MEADOW
10.03 AC. CULTIVATED
PRECIPITATION — INCHES
RUNOFF — INCHES
PEAK RATES - CFS / ACRE

Fig. 3 Rainfall-runoff relationship, Ozark Highlands

mine the probable 10, 25, or 50-year values. In using this method of analysis an assumption is made that the period of record is a good sample of a longer period of record. On log probability paper designed by Hazen, Whipple, and Fuller for plotting stream flows, the extension of the curve is comparatively short (Fig. 1) and greater accuracy can be expected than from logarithmic plottings.

Since the experimental watersheds are of small area and variable as to cover, the rate-size relationship curve can best be developed by plotting instantaneous peak rates of flow of streams within the land resource problem area. It is indeed unfortunate that there are so few data available on stream gagings of drainage areas ranging in size between 1 and 40 sq mi. A size-factor curve was developed for the Ozark Highlands land resource area by plotting instantaneous peak rates of flow of seven streams whose watersheds lie within the St. Francis River drainage basin.

These data were furnished by the U. S. Geological Survey surface water supply division for that area. The drainage areas above the gaging station ranged in size between 14.4 and 47 sq mi. These gaging stations were maintained for only a portion of the year 1939. Instantaneous peak rates of flow for eight storms that each covered the seven watersheds were plotted on logarithmic and semilog coordinates, and curves were drawn which best fitted the points. From these curves a single curve was chosen and extended to obtain probable values for smaller acreages. This curve, known as the size-factor curve for the land resource area, is used to extend the application of the 10, 25, and 50-year values determined for the individual experimental areas to cover a wide range of watershed sizes. By changing the posi-

tion of the size factor curve with respect to the "Y" axis so as to pass through the peak rates for 10, 25, or 50-year frequencies for each of the soil covers, peak rates of runoff for different sized areas and covers may be determined.

Total Water Yield. The water yield of a drainage area depends on many factors or combination of factors, among which are soil permeability, rainfall intensity, duration of storm, total precipitation, kind of cover, density of soil cover, soil moisture content, temperature, season of the year, and others. The intensity, total precipitation, duration, and frequency of storms will vary considerably throughout the year and within any one season of the year. However, within this climatic region one can state generally that the storms with the highest intensity rates occur during the growing months of April to October inclusive, and that during the balance of the year the storms will be of lower intensity rates and of longer duration; also that low intensity storms are not as localized as the flash storms with high intensity rates.

As one might expect, the water yield is not directly proportional to precipitation but is a function of it. In order to arrive at an estimated water yield for any given watershed and cover, based on the results of the watershed studies, the precipitation and runoff were computed by storms and then grouped by months and seasons of the year. These data were then plotted on logarithmic coordinates and a curve drawn which best fitted the points. Trial plottings indicate the grouping by months to be included, such as a 5-month growing season of May to September inclusive and its 7-month complement of October to April inclusive. These curves are used as a basis upon which to calculate the runoff for similar cover, soils, and watershed conditions.

The probable water yield from the watersheds is determined by checking long periods of rainfall records to determine one or more stations that might be considered representative of the region. The records of these stations are investigated further by checking total precipitation for seasons corresponding to those chosen for the watershed studies. From this long-time record the minimum inches of precipitation that has occurred on an average but once in 5, 10, or 25 years can be determined. This is a minimum that can be depended upon 80, 90, or 96 per cent of the time. With these precipitation values, the corresponding runoff value is read directly from the watershed curve for the seasonal grouping.

In conclusion, the author wishes to point out that the relationship between runoff and precipitation is not a simple one but is composed of many influencing factors, few of which remain constant. Also that the watershed studies have been in operation but a few years and that any recommended values at this time are tentative and subject to revision in the light of future records.

Soil Mechanics of Small Earth Dams

(Continued from page 211)

are intended primarily to indicate the possibility of types of construction not now considered conventional.

Fig. 3a shows a section through a conventional earth dam. It is assumed that the base is impervious. Although this is never true, it is common practice to design the fill as if it were. The embankment contains a core that has the function of preventing water from seeping through the dam. The downstream and upstream shells exist only to hold the core in place. The upstream shell must remain stable regardless of the water level, so it must be of carefully selected material. The requirements for the downstream shell are not so severe unless a pervious foundation exists. Then the possibilities of softening and uplift must be considered.

Fig. 3b shows a radically different section. The core is still present and it retains its function of holding back the water. It merges into a blanket or into a cutoff wall to reduce the flow through the foundation. The upstream shell protects the core and holds it in place. Therefore, it must be stable. However, it is not necessary to make half the dam of selected material. The core may be placed near the upstream face to minimize the amount of protective material required.

The downstream shell rests upon a filter. The filter together with the core isolates the downstream shell from water and as a consequence the shell can be made of almost any material. Since the core is near the upstream face of the dam, the downstream shell is relatively large and considerable economy may result from the use of what would otherwise be considered inferior material.

The preceding example is merely a suggestion of the arrangements that might be considered in connection with a given dam. In many instances the dam may consist of a homogeneous fill made of a fairly stable and fairly impervious material. In accordance with the opening remarks of this discussion, it is preferable to spend the largest amount of time and thought on the foundation conditions of a dam because the embankment is likely to be safer than the foundation.

Soil mechanics has provided the engineer with certain tools for investigating soil deposits and has provided him with theoretical concepts that aid him in understanding the interaction of soil and water in and beneath dams. The techniques are sometimes complicated and expensive, and their use may often be unjustifiable in connection with small structures. However, the knowledge gained from a study of larger structures has drawn the attention of engineers to the importance of understanding the foundation conditions at each site and of recognizing the limitations of this understanding. This is possibly the greatest single contribution of soil mechanics to the art of designing and constructing earth dams.

Barn Hay-Drying Research

(Continued from page 209)

It must be remembered, however, that crushed hay will absorb moisture as fast as or faster than uncrushed hay, in case it gets rained on. And one or more hard rains will cause the loss of a large percentage of the nutritive value of any hay.

DECREASE IN DRYING RATE

In all the test work on mow curing systems the rapid decrease in drying rate toward the end of the process has been apparent. This has been attributed largely to air leakage and to uneven drying.

A look at the relation between equilibrium moisture content and relative humidity shows a further reason. Curves like those in Fig. 7 were determined in tests made by S. T. Dexter, F. W. Zink, N. C. Wright, and others.

With data from psychrometric charts it is possible to calculate the amount of moisture that will be removed with known temperatures and humidities of the entering and exit air. Conditions of the former depend on the weather and of the latter on the moisture content of the hay. Thus the rate of moisture removal varies between such wide limits that simple, general rules cannot be applied to specific cases with any degree of satisfaction.

Figs. 9, 10, and 11 show how the moisture absorbing capacity of air changes with varying conditions of temperature and relative humidity. Fig. 12 shows graphically why the drying rate decreases as the moisture content of the hay is reduced. From the curves of this figure one can see why the amount of air required to finish the drying process is much greater than that used to remove an equal amount of moisture while the hay is still relatively wet.

CORRECTION

THE authors of the article, entitled "Irrigation Requirements of South Carolina Soils", on pages 157 and 158 of AGRICULTURAL ENGINEERING for April, 1948, call attention to the following corrections:

The formula just above Table 5 on page 158 should read as follows: $AWC =$ (Per cent water at FC − per cent water at WP) × volume weight/100.

The caption of Table 6 on the same page should read "Table 6. Surface Inches of Water Required, etc."

Dairy Barns in New Jersey

By Harry E. Besley
MEMBER A.S.A.E.

PLANS and other information on dairy barn construction have been distributed to farmers for many years. In order to obtain some indication of the effectiveness of the advertising and educational programs and also to determine just what manner of dairy barn New Jersey farmers are using, a survey of 162 dairy barns was made in 1944-45.

This survey was made by the New Jersey Agricultural Experimental Station with support from the National Mineral Wool Association. The farms were selected from dairy herd improvement association membership lists to give an accurate cross section of New Jersey dairy farms operated by the better farmers in the state. A schedule or questionnaire, designed to obtain the desired information, was prepared at the experiment station and was checked by representatives of the National Mineral Wool Association. Milk testers, known to the cooperating farmers and familiar with their barns, conducted the survey.

In considering the data collected, it should be kept in mind that while the operators are classed as better farmers, many of their barns preceded them on the farms. The average barn represents structures now in use, not necessarily what the farmer would build today.

The average or composite barn found in the survey is a two-story, gable-roof structure with concrete floor. It may be constructed of either wood or masonry, about a fifty-fifty chance either way. The roof is likely to be wood or slate, and the older the barn, the greater likelihood of finding slate. There is little consistency regarding interior finish except in the use of whitewash.

A tabulation of interior finishes showed the interior wall not surfaced in 52 per cent of barns, ceiling not surfaced in 48 per cent, frame barns never painted on inside in 10 per cent, whitewash for interior coating in 71 per cent. Farmers using whitewash apply it once or twice a year.

Space allowances vary between quite wide limits, but on the average compare quite favorably with present recommendations.

Number of stalls varied from 12 to 118, averaging 49. Platform widths, from 2 ft 9 in to 5 ft 0 in, averaged 3 ft 5½ in. Platform lengths, from 4 ft 0 in to 6 ft 9 in, averaged 4 ft 10 in. The most common widths and lengths were 3 ft 6 in and 4 ft 6 in to 5 ft 0 in.

Tapered platforms were used in 46 per cent of the barns, face-out arrangement in 40 per cent of barns, and sweep-in mangers in 66 per cent.

Feed alley widths averaged, for face-in arrangement, 6 ft 3 in; face-out, 5 ft 4 in.

Litter alleys averaged, for face-in, 4 ft 4 in; face-out, 7 ft 4 in. Short barns usually have a cross alley at one end, and longer barns, one at each end.

Most of the barns are wired for electricity, but the jobs are installed when "adequate wiring" was in its infancy, possibly even before "adequate" was born. There is an average of only eight lights per barn and these are 40 watts or less. Lights per feed alley are two or less. Lights per litter alley are four or less. Convenience outlets were lacking in 75 per cent of the barns.

Every farmer seems conscious of a need for air change in the dairy barn and some attempt is made to provide the required ventilation. Silos or hay chutes were used for ventilation in 56 per cent of the barns. Water froze in 24 per cent of them, and 29 per cent had wet walls. Window ventilation was provided in 14 per cent of the barns. Water froze in 30 per cent of them and 31 per cent had wet walls. Flues in 19 per cent of the barns let water freeze in 26 per cent of them and 13 per cent had wet walls. Mechanical systems in 11 per cent of the barns prevented freezing of water in all cases, but 17 per cent of these barns had wet walls.

Considering the number of wet walls, some improvements in ventilation are in order. And judging by the frozen drinking water, there is the probability that some consideration should be given to increasing the amount of insulation used. And speaking of insulation, confusion runs rampant on this point.

Masonry walls in 49 per cent of the barns were not insulated in any case. The 51 per cent of barns with frame walls had insulation in 72 per cent of the cases. It was fill or commercial insulation in 28 per cent of them. Ceilings had some insulation in all cases, varying from ⅞-in lumber to a hay mow. Only 11 per cent had any moisture barrier in ceiling or wall. None had storm windows.

There does not seem to be a clear understanding of the relative insulating values of various materials. For some reason, ⅞-in lumber gives a feeling of security in so far as insulation is concerned. The same thing is true of cement asbestos shingles. When a farmer applies these shingles to his barn or house, he thinks he is really insulating the walls.

There is also very little appreciation of the need, function, and application of moisture barriers. Only nine barns were reported as being vapor-sealed; of these five had ordinary building paper in the walls and three had it in the ceiling. It might be worth while for manufacturers to concentrate more on training their dealers in the use of moisture barriers. Certainly the farmer would not be so lacking in understanding of this subject if his materials dealer was a little better informed and shared his knowledge with the farmer.

Most barns are fully equipped with such items as drinking cups and milking machines, but there is still quite a market for certain electrical equipment and manure-handling devices.

Equipment in barns included milking machines, 88 per cent; feed carts, 70 per cent; electric milk coolers, 48 per cent; and electric water heaters, 20 per cent.

Drinking cups for cows are available in all except four barns. One cup for two cows is used in 80 per cent of the barns.

A wheelbarrow is used for handling manure in 36 per cent of the barns. Certainly this indicates room for improvement. The manure is removed from the barn at least once a day and generally twice.

The average herd numbers 55 animals. These include 34 milk cows, 20 heifers, and 1 bull. The average cow produces annually 8369.4 lb of milk and 328.8 lb of butterfat.

The cows are generally milked twice daily by one to three men in one to two hours.

The average barn just examined represents to a large degree what the farmers have inherited and are now using. Barns being built today vary in many respects from this average barn.

In New Jersey, the new barn is generally constructed of masonry, probably concrete or cinder block. Whether it is one or two story will depend in many instances upon the farmer's experiences with fire. If he has had a mow fire, the new barn will probably be one story with a gable roof.

One and one-half and two-story barns will usually have a gambrel roof. Sheet aluminum and asphalt shingles are common types of roofing materials.

Space allowances in the new barn are more liberal. Barn widths of 38 and 40 ft are common. Platforms are usually 3 ft 8 in to 4 ft 0 in wide and 5 ft 0 in or more long. A face-out arrangement is almost always used.

"Adequate" has had a hand in the wiring so there are ample lights and convenience outlets.

Some insulation is used and a controlled ventilation system is generally installed. *(Continued on page 217)*

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Farm Structures Division.

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Runoff and Soil Conservation Practices

By Ralph W. Baird
MEMBER A.S.A.E.

ATTEMPTS to determine the effect of conservation practices are usually designed to give the effect of each practice separately. From these individual effects, attempts are made to approximate the total effect on a larger area where all practices are involved. In making this attempt many approximations and estimates are required.

At the Blacklands Experimental Watershed near Waco, Texas, facilities are available to study the effects of combined practices on rates and amounts of runoff and to a smaller degree on soil losses. The experimental layout has two quite similar areas of about 300 acres each with each further divided into smaller areas. Runoff measurements are available from each of these areas and soil loss measurements from some of them.

During the period 1937 through the crop year 1942, ordinary farming practices with straight rows were used on all areas. In the fall of 1942 an improved crop rotation was started, some areas were retired from cultivation to pasture and meadow land, and sloping cultivated land was terraced on one of the 300-acre areas (*Y*). The other 300-acre area (*W*1 and *W*2) was continued with the ordinary practices (Fig. 1). By comparing the two areas before and after treating one of them, the effect of conservation practices can be determined.

The ordinary farm practices in this area called for approximately one-half the cultivated land in cotton, one-fourth in corn, and one-fourth in oats, sorghum and other crops each year. A small amount of meadow and pasture was also included in most farms. With the improved rotation started on the *Y* area in the fall of 1942, the general plan was one-third of the cultivated land in cotton, one-third in corn, and one-third in oats overseeded with Hubam clover. Some of the steeper areas had a two-year rotation of corn followed by oats overseeded with Hubam clover, and some good footslopes had a two-year rotation of Hubam clover harvested for seed, followed by cotton or corn. In addition a considerable amount of land has been retired from cultivation to pasture. The terraces used on the *Y* area were all variable-grade terraces with terrace outlet ditches sodded with Bermuda grass. To retain the smaller natural watersheds, terraces are somewhat shorter than is common practice in this area (Fig. 2).

As the comments on runoff rates and amounts will be limited to five areas, details of the crop distribution for these areas are given in Table 1 for the year 1942 before any changes were made, and for the year 1947 after the conservation plan had been in operation several years on the *Y* area. The increase in the acreage of pasture and meadow has been made largely by the reduction in the cotton acreage.

The years 1937, 1938, and 1939 were very dry years with practically no runoff. A number of runoff periods of considerable magnitude occurred before the conservation practices were established on the *Y* area in the fall of 1942. Work was greatly curtailed in July 1943 and runoff records are available for only three stations during the wet years 1944 and 1945. Since 1945 some stations have been reestablished and, although the record from these reestablished stations is short, some reference will be made to it.

The effect of the land changes on peak rates of runoff has been quite well determined for the 132-acre area *Y*-2 (Fig. 3).[1] From the record through 1945 conservation practices have resulted in lower peak rates of runoff but the effect appears to be slightly less for the larger floods. On the heavy black clays of the area during long storms or rainy periods a condition is reached where almost all rainfall appears as runoff. Under these conditions only those practices which reduce the velocity of flow or amount of temporary storage will affect runoff rates. The temporary storage of water in terrace channels plays an important part in the reduction of peak flows.

From analyses of the data for the period of record, conservation practices would have reduced the peak rate of runoff from area *Y*-2 for the storm of June 10, 1941, from 3.05

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Soil and Water Division. The studies reported were conducted by the Soil Conservation Service, USDA, in cooperation with the Texas Agricultural Experiment Station.

RALPH W. BAIRD is project supervisor, (research), Soil Conservation Service, U. S. Department of Agriculture (P.O. Box 1583, Waco, Tex.).

[1] Separately reported in a paper presented before the Texas Section, American Society of Civil Engineers, May 10, 1946.

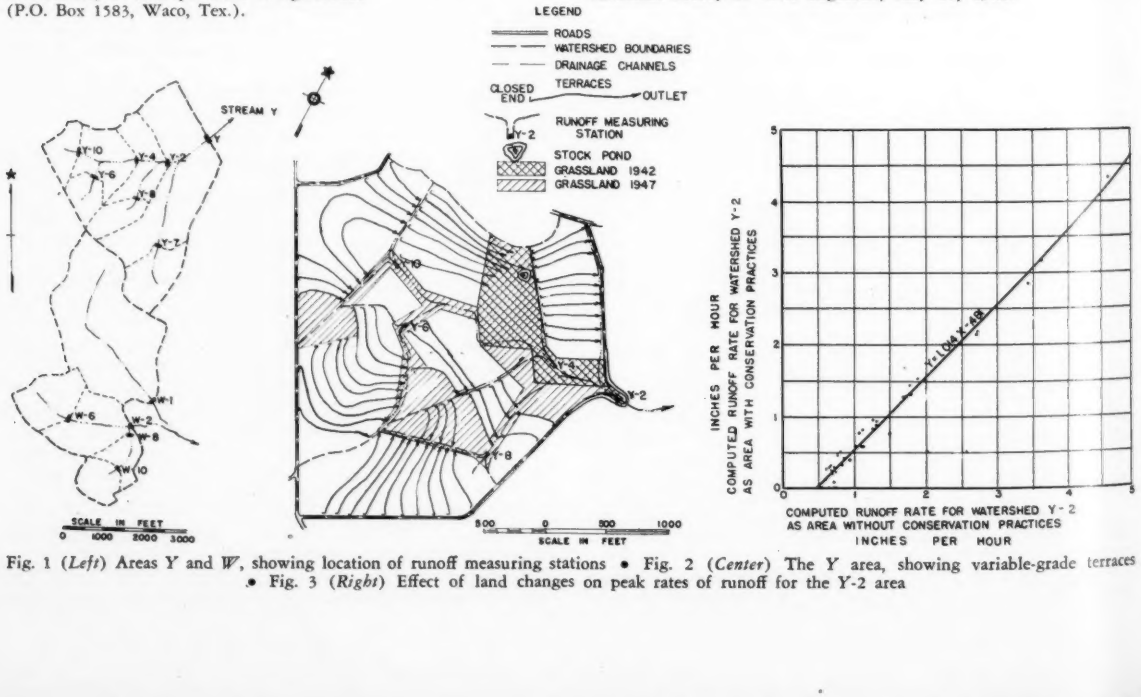


Fig. 1 (*Left*) Areas *Y* and *W*, showing location of runoff measuring stations • Fig. 2 (*Center*) The *Y* area, showing variable-grade terraces • Fig. 3 (*Right*) Effect of land changes on peak rates of runoff for the *Y*-2 area

TABLE 1. LAND USE

Crop	Area *W*-1 176 acres		Area *W*-10 19.7 acres		Area *Y*-2 132 acres		Area *Y*-6 20.9 acres		Area *Y*-10 21.0 acres	
	1942 Per cent	1947 Per cent	1942 Per cent	1947 Per cent	1942 Per cent	1947 Per cent	1942 Per cent	1947 Per cent	1942 Per cent	1947 Per cent
Cotton	47.6	34.6	49.3	52.0	46.1	22.9	50.2	32.1	50.0	28.8
Corn	22.8	18.1	25.9	35.7	22.7	25.6	24.9	19.3	25.8	29.7
Oats or oats with Hubam clover	14.3	20.7	24.8	12.3	18.6	22.6	24.9	33.5	24.2	27.8
Pasture or meadow	10.6	16.5	0	0	8.9	27.5	0	15.1	0	13.7
Sorghum and other crops	4.7	10.1	0	0	3.7	1.4	0	0	0	0

to about 2.50 iph (inches per hour), and for the storm of May 1, 1944, the actual peak rate of runoff with conservation practices was 4.07 iph but would have been about 4.50 iph with ordinary farm practices. From a comparable area with ordinary farm practices the measured peak rate of runoff on May 1, 1944, was 4.51 iph. The storm of June 10, 1941, had rainfall rates of 4.38 iph for a 25-min period, and that of May 1, 1944, 4.52 iph for a 25-min period.

Using a similar method of analysis, almost the same results were obtained for the 20-acre area, *Y*-10, with a shorter period of record which did not include such high rates. It is probable that, particularly for the smaller areas, the terrace length is a factor that must be considered.

The effect of conservation practices on the total amount of runoff is not as clearly defined and more data are needed before definite statements on the effect can be made. When the soil is relatively dry at the start of the storm period, there seems to be slightly less runoff from the areas with conservation practices. During long periods of wet weather when all soil moisture deficiencies are satisfied, there seems to be little or no difference between the treated and untreated areas. Considering the amount of area returned to permanent grass cover and measured runoff from grass lands both at Waco and elsewhere a considerable reduction in the amount of runoff should be expected, except when the soil is very wet. This result has not been apparent, possibly because some time is required before grasses have a great effect and possibly because of the location of much of this grassed area along stream channels. It is hoped that some information on an area returned to pasture can be obtained for comparison with native meadow areas.

Some information is also available on the amount of suspended material carried through the runoff measuring stations. Water samples have been manually collected in bottles from the water passing through the measuring flume at regular intervals during the major floods. While this method of sampling will not give the true total amounts, the relative amount from similar areas sampled in the same manner should be nearly correct. Records are available from two 20-acre areas, *Y*-6 and *W*-10, during 1941 when both areas were treated alike, and December, 1942, through June 1943 after the area *Y*-6 had conservation practices established. For 1941, *Y*-6 had measured soil loss of suspended material of 284 tons, while *W*-10 had 239 tons, or a ratio of 1.19 to 1. For the period December 1942 through June 1943 the amounts were 9.9 tons and 109 tons, respectively, a ratio of 0.09 to 1, or less than one-twelfth of that prior to treatment. Results may not be so extreme for the larger storms. Additional results on this subject are being obtained.

These results from the Waco Experimental Watershed are beginning to answer some of the questions regarding the effects of conservation practices on runoff for this area. When more of the stations now inoperative can be reestablished much more information will be available.

Dairy Barns in New Jersey

(Continued from page 215)

A few of the features incorporated in a recently completed single-story cinder block dairy barn will serve to indicate present day trends. Mineral wool insulation is used in the walls and ceiling. Moisture barriers have been placed on the inside surface of the insulation. A mechanical ventilation system is installed, with the attic serving as a plenum chamber. And, most significant, windows have been eliminated by the use of glass block.

COMMENTS

From an analysis of the data and from comments made by the farmers, it is evident that many of the better farmers in New Jersey do not have a satisfactory understanding of dairy barn ventilation. It is not uncommon in the state to find that a farmer has purchased roof ventilators and has not provided any flue connection to the stable below, even in two-story barns. In these cases the ventilators are rather expensive ornaments. It will be difficult to correct wet walls with such a setup.

There is also much confusion on insulation and the factors to be considered in its application. Literature is available which covers not only ventilation and insulation in dairy barns, but also the application of moisture barriers. Farmers do read, but if they are reading sales promotion literature and college publications covering these points, there is certainly a low degree of retention. Possibly the printed material should be critically re-examined, with the idea of making it more attractive and effective.

In view of the inadequacy of the ventilating systems and the insulation now on farms, there is a wide-open market in these items. There also appears to be an excellent opportunity to sell more adequate wiring installations and a wide variety of electrical equipment.

This market potential is especially significant when it is recalled that the barns included in this survey are on better dairy farms. When better equipped, other farms can be improved.

There is a definite trend to provide more space for animals and general agreement that larger stalls are desirable. Just how much bigger to make them is the question.

Additional studies on space requirements in dairy barns are certainly in order.

New Federal and State Bulletins

A Progress Report on the Investigation of the Various Uses of Electricity on the Farms of Washington (1947). This is the 23rd annual report to the Washington CREA. Subjects covered include electric poultry floor heating, frost expellers, pea vine drying, hay drying, electric house heating, and high-pressure pumps for cleaning poultry houses and equipment. Mimeographed. Limited distribution.

Design data for the area based on the best information now available are coordinated and condensed into one short reference.

Hydrologic Design of Farm Ponds and Rates of Runoff for Design of Conservation Structures in the Claypan Prairies, by D. B. Krimgold and N. E. Minshall, Soil Conservation Service (Research), USDA, in cooperation with the Illinois, Oklahoma, and Missouri Agricultural Experiment Stations.

A continuation, covering literature published since the beginning of 1946, of the bibliography published as Special Report No. 23 of the same station.

"Nation-Wide Conservation Drainage Operations"

TO THE EDITOR:

THE paper by John G. Sutton, under the above title in AGRICULTURAL ENGINEERING for January, appealed to me as a practical, down-to-earth description of the drainage activities of the USDA Soil Conservation Service.

It has been disappointing to me that there are so few papers on the soil and water programs of our meetings that deal with the problems faced by engineers and contractors engaged in the actual installation of drainage projects. These men certainly need more information, especially those designing and laying out drainage work, including not only the large drainage district jobs with open ditches and large tile mains, but also the smaller systems consisting mostly of laterals.

A number of years ago when county soil conservation offices were being set up in the Mississippi Valley states, I called on many of the local engineers in charge of these offices and was surprised to find how few of them had any practical knowledge of drainage work, although all were registered engineers. They were designing the drainage systems on the projects in their counties, and while able to make beautiful maps showing contours and most every kind of data, the really important parts of the system that make it a success or failure, such as depth, spacing, and design, too often showed a woeful lack of knowledge of local soil conditions and good drainage practice. In one state a competent drainage engineer was finally secured who designed all of the drainage work of the various county organizations, and the local engineers handled the details of administration and installation, which worked out much better.

In an effort to improve the quality of drainage work in the territory it serves, the Mason City Brick & Tile Company has sponsored an annual drainage conference to which are invited drainage engineers, contractors, soil conservation engineers, manufacturers of trenching equipment, representatives of agricultural colleges, and any others interested in drainage. Topics of general interest to the group are discussed by well-known authorities and the meetings have attracted large attendances. Many of the visitors indicated their desire to attend a short course of instruction in drainage foundations, so Iowa State College has prepared a splendid four-day program along this line which is being offered this month. The purpose of the course is to help the man actually installing the drain tile to do a more efficient job.

Getting back to Mr. Sutton's paper, the illustration on page 23, of the cross section of an open ditch, is of much interest to me. The State of Iowa has many large drainage systems which include open ditches, and the permanence of these ditches is very disappointing. In the opinion of many of us here, the design was often faulty and largely to blame, in many cases, for their gradually decreasing efficiency as outlets. Lack of upkeep and maintenance contributed also, but due to the way they were constructed it was impossible to keep them in good condition without great expense.

In the first place, the ditch banks were not given enough slope. Ratios of one foot vertical to one horizontal or less were of common occurrence which prevented them from grassing over. Portions of the ditch banks slough off to form dams which catch sediment carried in suspension by the current, thus raising the floor of the ditch. Weed burners had not been perfected and mowing machines could not be used to keep the brush and weeds from flourishing. During periods of high water, the weeds and brush collected trash and dirt, slowed the current which prevented the ditch bottom from being scoured out clean, and more sediment was collected in the ditch. We feel that the slope of the sides of the open ditches should be about the same as those used in cuts through hills in highway construction. Grass will grow on any slope where a highway mower can operate, and if seeded after construction, and then mowed at the proper time each year, the ditch banks can be held and kept free from brush and trees.

Spoil banks should always be smoothed and seeded. Then regular mowing or pasturing will keep down the trees which start to grow as soon as the job is completed. Under the old method, the excavated dirt was dumped in large piles wherever it was convenient for the machine operator, so it was impossible to mow over the spoil bank or use it for agricultural purposes. Cottonwood, willow, and other quick-growing trees generally grow on the old spoil banks, and limbs and leaves from them fall into the ditch and interfere with the free passage of the current. Canada thistle, button weed, quack grass, and many other noxious weeds grow undisturbed on the rough spoil banks, and their seed is distributed by wind and water over large areas.

Because new ditches and clean-out jobs are still showing the same faulty design in both the vertical sides and rough spoil banks, the writer, who is a member of the Iowa legislature, introduced an addition to the Iowa Drainage Law at the last regular session which would require all new construction and clean-out jobs on public works open drainage ditches to be so designed that they could be mowed by highway-type mowers, and that they be seeded to approved grasses and mowed at stated times each year, the expense to be borne by the district. Also, that the spoil bank be smoothed and seeded and regularly mowed at the expense of the district unless it was used for agricultural purposes which prevent the growth of weeds, trees, and brush. The bill failed in the Senate after passing the House, but an attempt will again be made to pass the bill at the next session. While the first cost of construction is larger for the ditches with sloping sides and smoothed spoil banks, I feel that the longer life and reduced maintenance expense of the properly constructed mains will show them to be much less expensive over a term of years, besides giving much more service to the drainage outlets they were built to serve.

W. S. LYNES
Drainage consultant
Mason City Brick & Tile Co.

"Engineering-Management Aspects of Self-Propelled Farm Machines"

TO THE EDITOR:

THE paper, entitled "Engineering-Management Aspects of Self-Propelled Farm Machines," by E. L. Barger, in AGRICULTURAL ENGINEERING for March is an excellent one. There is one thing in it, however, with which I disagree, namely, crediting the self-propelled machine with 50c per hr (or any amount) because it releases a tractor for other work. This is a faulty method of estimating costs. It should not become a common practice for the following reasons:

1 The owner pays for the release by making the investment in the additional engine and drive mechanism. This cost should be charged to the crop harvested by the self-propelled machine and should not be nullified by a credit.

2 This method leads to absurd cost figures. For example, suppose a team is used to mow hay, thereby releasing a tractor to cultivate corn. By this reasoning, we would credit the team with 50c per hr, making the horse labor cost nothing.

3 If 50c per hr is credited to the self-propelled machine, that amount should be debited to the job which the tractor does. This debit is in addition to the normal charge for tractor work. Thus the fixed cost of the tractor is doubled on this job so that the self-propelled machine will appear in a more favorable light.

A. W. CLYDE
Professor of Agricultural Engineering
Pennsylvania State College

"Quantitative Measures of Hay Quality"

TO THE EDITOR:

WE HAVE noted the editorial, entitled "Quantitative Measures of Hay Quality," in AGRICULTURAL ENGINEERING for February 1948. As you know, the U. S. Department of Agriculture has had standards of quality for hay since 1924. These standards have been used to a certain extent by the hay trade and also by some of the research people in agricultural colleges and the Department, to measure the quality of hay produced by various harvesting and curing methods, as well as hay which is used in various feeding experiments.

In these standards, color is used as a grading factor in all types of hay, and some work indicates that there is a correlation between green color and carotene content, at least in the year in which the hay is produced. Hay which is carried over from one year to another loses its carotene content to a greater extent than it loses its color and, under these conditions, the color of the hay is not a good measure of its carotene content.

In the standards for legume hays, leafiness is also a grading factor, and this, in turn, is a measure of the protein content of the hay, since the leaves of the legumes are considerably higher in protein than the stems.

Variations in the feeding value of hay, depending upon the kind or mixture of kinds, is taken care of in the standards by the classes. For instance, mixtures of timothy and clover would fall into one of four classes—Timothy, Timothy Clover Mixed, Clover Timothy Mixed, or Clover—depending on the amount of clover and timothy present in the hay.

We have recognized for a good many years that feeding tests using specific grades of hay would add considerable information to our standardization program, and at present are hoping to have such a program in operation within the next year. We would appreciate any suggestions which you might have with reference to improving the hay standards or plans whereby the standards could be used to determine the quality of specific lots of hay which are used in research work by the agricultural engineers.

W. H. HOSTERMAN
Inspection Division, Grain Branch
Production and Marketing Administration
U. S. Department of Agriculture.

(EDITOR'S NOTE: Readers will please note the invitation in the last paragraph of Mr. Hosterman's letter, and send him any suggestions they may have relative to improving hay standards, etc.)

RESEARCH NOTES

A.S.A.E. members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.

USDA Notes on Rural Processing, Electrification Research Personnel, and Heat Pump

By JANE TUTTRUP

Rural Processing. Although the Research and Marketing Act has given a new impetus to agricultural engineering research on the processing of farm products, this field of work is by no means new to the profession. A significant shift in emphasis is, however, taking place in the field.

Cotton processing investigations began over 20 years ago and have resulted in a series of very solid improvements in ginning machinery and techniques. For ten years also flax fiber processing has benefited from study by federal and state agricultural engineers. During the war agricultural engineers applied their experience and skill to meet a serious shortage of imported hard fibers. These are examples of the application of agricultural engineering to farm products processing problems. Research on these older problems of processing is continuing.

The current and newer processing research is related less closely to specific commodities and more closely to the rural economy as a whole than the research of the past. Local processing of the human and animal foods from southern farms that are adopting diversified agriculture is important in raising the standard of living through the improvement of diet and cash income from off-farm employment. Many cooperative and private community enterprises need engineering help in developing efficient machinery, layouts, and techniques.

USDA agricultural engineer W. M. Hurst, who divides his time between BPISAE's Division of Mechanical Processing of Farm Products and the Farm Credit Administration's Cooperative Research and Service Division, has been and is doing a number of interesting jobs related to farm products processing. In a survey for FCA he studied in considerable detail the layout and operations of cooperative poultry dressing plants, principally in the high-producing areas of the North and South Atlantic States. Thirteen such plants, ranging in size from those turning out 500 to those turning out 3,000 dressed birds per hour were visited to study engineering factors of plant design and operations. As a result of this work, a report containing suggested plans for plants of various capacities was issued, and some of the plans have already been used. Pending needed research to reduce the labor required in removing feathers, to chill birds quickly on the dressing line, and to weigh and grade mechanically and quickly, the survey findings are proving helpful to individuals and groups contemplating plant construction or modernization.

Good primary outlets for farm products—markets where farmers sell their products, usually directly to the consumer — make the difference between success and failure for many operators of small farm units. In 1946 there were approximately 750 of these markets in the country. In response to many requests for plans and specifications for primary-market facilities, a report has been issued containing descriptions and sketches of plans covering farm women's home markets and farmers' city retail, city wholesale, wholesale redistribution, wholesale regional, and wholesale shipping-point markets.

A report also is in preparation on a survey of locker storage plants in Georgia made last year in cooperation with Harold D. White of the agricultural engineering department, University of Georgia. Particular attention was given to the auxiliary processing enterprises carried on in connection with the locker plants, as in many cases such enterprises are necessary to the financial success of locker plants.

Under a new Research and Marketing Act project on "Improvement of processing facilities and equipment for rural plants for processing farm products," work in cooperation with the University of Georgia, now being organized under Mr. Hurst's direction, will deal with (a) locker plants and auxiliary processing facilities and equipment, (b) canning plants and auxiliary equipment, and (c) the processing of livestock feed, including dehydration, grinding, mixing, and packaging. These problems are of particular importance in Georgia at this time but the results obtained will be of value to the entire region.

Following field studies of existing plants to determine the engineering problems associated with the design of plants and their equipment and the possibilities of developing better processing equipment to save costs or improve quality of the product, it is planned to design, develop, and test improved handling, processing and packaging machinery, equipment, and methods. The work will be centered at Athens, Ga.

Since the Georgia work will occupy a considerable part of Mr. Hurst's time, George A. Amacker has been appointed to assist with the FCA cooperative projects, with headquarters in Washington. Mr. Amacker has had wide experience in farm products processing engineering, particularly the dairy industry.

Rural Electrification Research Appointments. Two engineers have recently joined the staff of the Division of Farm Electrification. At Beltsville, Lowell E. Campbell is assisting Leonard G. Schoenleber with the hay drying work and will later devote his time to investigating agricultural applications of supersonic energy. Campbell comes from Ohio with degrees in agriculture and agricultural engineering from Ohio State University. His four years as an officer in the army included air force communications work in India and Germany.

Andy Altman has transferred to Agricultural Engineering from REA's Technical Standards Division, where he has specialized in electrical farm equipment. He is stationed at the Tobacco Experiment Station, Oxford, N. C., to assist Dr. O. A. Brown with the curing studies. North Carolina is Altman's home state. He has a BS from the University of North Carolina and an MS from the University of Georgia, both in agricultural engineering. As an army officer he served in bomb disposal operations in the Southwest Pacific.

Heat Pump. Possibilities for farm applications of the heat pump were subject to lively discussion by the research committee of the National Rural Electric Cooperative Association at its annual meeting in Chicago, March 8 to 10. Considerable interest in exploration of this use of electric energy was indicated. Time also was given to discussion of the heat pump on the program of the 20th annual California farm electrification conference at Davis, February 16 and 17.

Although several manufacturers and electric utility companies have been making commercial and residential installations involving use of the heat pump for a number of years, little research has been done by federal or state agencies on this unit. In June, 1947, the Florida Engineering and Industrial Experiment Station published Bulletin No. 14, "Reverse Cycle Refrigeration for Heating in the South," by S. P. Goethe.

Among possible farm applications of the heat pump, in addition to house heating and air conditioning, are its use for heating and cooling fruit, vegetable, and seed storage buildings, chicken houses and dairy barns. The Division of Farm Electrification, USDA, in cooperation with Iowa State College plans to get records of temperatures maintained and energy consumption on a heat pump installation in northeast Iowa. Other studies also are being considered.

USDA Notes on Rice Conditioning, Weed Control, Drying Corn, Insulation and Weatherproofing

By JANE TUTTRUP

THE new Beaumont Substation No. 4 of the Texas Agricultural Experiment Station is headquarters for the cooperative Research and Marketing Act project to improve methods, structures, and equipment for the drying and storage of rice. Establishment of the project headquarters was accomplished at a meeting in Beaumont, April 14-15.

Land for the new branch station is being leased to the state by the Texas Rice Improvement Association, a non-profit organization incorporated to produce and distribute seed of new rice varieties and support research on rice problems. A quonset hut will be erected for immediate use pending the building of a permanent laboratory. Harold A. Kramer is being transferred to Beaumont to be the USDA agricultural engineer in charge. He has been working with Russell Ramp at Houma, La., on the Farm Machinery Division's cooperative sugarcane mechanization project. Before that he had three years' experience in rice drying and storage research with the Louisiana Agricultural Experiment Station.

The new investigations will be divided into the following four phases:

1 A laboratory study of the fundamental factors influencing the drying and storing of rice. This phase will receive first attention at the headquarters station. It will include the effect of temperature, rate of drying, original moisture content, and related factors on the milling quality of the dried rice and on the cost of drying.

2 A study of long-time storage of rough rice on the farm and in cooperative and commercial elevators. This will include investigations of size and arrangement of bins, bin materials, optimum moisture content of the rice, and other pertinent matters.

3 A study of drying equipment of sizes and types suitable for farm or commercial operation. This study will also include work on cleaners, conveyors, and related equipment used in conjunction with a complete drying installation.

4 A review and analysis of existing literature on rice drying and storage to be used as a basis for a mimeographed circular for use by rice growers before next year's harvest and as a guide for those on the project in planning and conducting their research.

It was proposed at the Beaumont meeting to establish a committee to be responsible for the over-all planning and co-ordination of the work of the co-operating agencies. According to the proposal, experiment stations of Texas, Louisiana, Arkansas, and California will be invited to appoint representatives to the committee. The membership would also include representatives of state rice growers associations and of the co-operating federal agencies.

Weed Control. Several fields on the Agricultural Engineering Research farm at Ames, Iowa, will be used this season for studies under the Research and Marketing Act weed control project announced by the USDA late last year. Treatments to which the various plots will be subjected are based on suggestions evolved from the proceedings of the North Central Weed Control Conference at Topeka, Kansas, in December, 1947. They were selected primarily to furnish information on the design and use of equipment, although crop-stand, crop-growth, and crop-yield data as well as the presence of weeds throughout the season will be used as criteria for evaluating the various practices.

Detailed plans are prepared for replicated tests involving oats under 14 different treatments, early and late soybeans under 10 different treatments, and corn and sweet corn under 16 different treatments. Included among the practices to be tested are herbicidal sprays, alone and also in combination with the use of flame and cultural controls. On other College-owned land near Ames some 500 gallons of 40 per cent 2,4-D and 2,4-D esters will be sprayed on crops at different times throughout the season, and this operation, while not purely experimental, will provide additional experience and cost data for various types of application equipment.

The USDA agricultural engineer in charge of the engineering phases of weed control work at Ames is Robert A. Norton, who recently transferred to the Division of Farm Machinery from the Soil Conservation Service.

The three phases of investigations on weed control—tillage and cultural control, use of flame, and application of herbicides—are being developed in close co-operation with the Research and Marketing Act cotton mechanization project. In addition to work at Beltsville and at Ames, tests will be made at Stoneville, Miss., where the emphasis will be on use of flame, and at St. Paul, Minn. There is considerable interest in herbicide application in Minnesota, and many spray equipment manufacturers are located there.

Drying Corn. Increases in the values of high-moisture ear corn of from 20 to 70c at fuel and power costs of 2½ to 9½c a bushel were obtained with experimental driers using forced heated air by USDA agricultural engineers in research carried on co-operatively during the past winter with several corn belt state experiment stations, according to a preliminary report.

The preliminary data were from work on the drying of approximately 80,000 bu of ear corn in 45 cribs, of which 20 were in Illinois, 17 in Indiana, and 8 in Ohio. Complete data from the winter's investigations, which ended early in April with the drying run on corn in cribs on Illinois and Michigan farms, are now being analyzed to determine modifications in the design of driers for farmers that may be recommended to manufacturers.

Typical of the results of the drying experiments are those obtained on the J. C. Wise farm near Villa Grove, Ill., in the work co-operative with the University of Illinois. In this test heated air was forced through 2,640 cu ft of ear corn (982 seventy-pound bushels at original moisture content) for 70 hr to reduce the kernel moisture content from 23 to 17 per cent. The drier used 183 gal of fuel oil at a cost for fuel and electric power of $30.87. Of the initial weight of corn, 7 per cent was lost by drying, but the price discount in effect was 31c a bushel on corn at 23 per cent moisture and only 6c at 17.3 per cent moisture. The corn weighed out to 914 seventy-pound bushels when sold and brought $2.23 a bushel, or $2,038.23. The 983 seventy-pound bushels of corn at 23 per cent moisture would have sold at $1.98 a bushel for a total of $1,944.36. The net gain after deducting fuel and power costs was $63, or around 6½c a bushel.

Another striking experience is that reported by the department of agricultural engineering at Purdue University of an Indiana farmer who was urged to sell his corn without drying at $1.85 a bushel. He refused to sell, went ahead with his preparations for drying, and before the drying was finished the same buyer came back to the farm, spent half a day observing the drying operation and sampling the corn, and then offered to buy it at $2.60 a bushel.

The corn drying project was organized last summer when it appeared that much of the 1947 corn crop would be "soft" and was the first of the investigations to be authorized under the Research and Marketing Act of 1946. Especially in Illinois, Indiana, and parts of Ohio and Michigan, some of the 1947 crop did not fully mature and had to be harvested at a moisture content too high for safe storage. Artificial drying saved for spring feeding much ear corn that would otherwise have spoiled. Twenty types of driers were used in the research program, including seven built to specifications drawn up by the agricultural engineers on the basis of their earlier laboratory studies. These included units burning from 1 to 15 gal of oil per hour and delivering from 500 to 20,000 cu ft of heated air per minute as well as both hand-fired and stoker-fired coal heaters and gas-burning units.

Continuation of this research on corn drying or conditioning is expected to bring improvements in drier design and more effective ways of adapting corn cribs for uniform distribution of air through the corn. Costs of the experimental driers ranged from about $900 to $3,000, but it is expected that these costs will be reduced by improvements in design and by mass production. When used on a custom basis, engineers say a drier should dry 20,000 to 40,000 bu or more of corn per season.

Indicative of the interest in artificial drying of corn were the demonstrations of crib preparation and drying arranged by the department of agricultural engineering of the Purdue University Extension Service and the Production and Marketing Administration in Indiana attended by about a thousand farmers. Many farmers have indicated that they would like to dry corn every year. They say it will permit them to pick their corn early and be out of the fields before bad weather begins. Also, there is the possibility of seeding fall wheat following the corn, thus gaining greater freedom in crop rotation, and they can avoid picker losses of from 2 to 10 bu an acre that occur when corn is harvested dry.

Insulation and Weatherproofing. Just off the government press is the USDA'S Miscellaneous Publication No. 633, "Your Farmhouse—Insulation and Weatherproofing," another in the series of housing publications on which the Division of Farm Buildings and Rural Housing is collaborating with other agencies of the Department. The bulletin was prepared by Harry L. Garver, J. Robert Dodge, Marguerite Gilstrap, and Elinor Ulman of the Bureau of Plant Industry, Soils, and Agricultural Engineering. Its 16 pages include 26 illustrations.

Printed in two colors, the publication presents graphically detailed information on where and how to install weatherstripping, calking, storm sash, board, blanket, and fill insulation, reflective insulation, and vents. Impressive data on how insulation and weatherproofing make for more even temperatures and save fuel are taken from studies on farmhouse comfort made by the Division of Farm Buildings and Rural Housing in co-operation with the University of Wisconsin.

Another in the "Your Farmhouse" series issued recently is "Planning the Bathroom," Miscellaneous Publication No. 638, prepared by the Bureau of Human Nutrition and Home Economics and the agricultural engineers. In addition to location, plumbing, and fixtures the publication discusses such questions as wall finishes, floor coverings, storage and accessories, heating and lighting. A number of floor plans are presented, including suggested arrangements for making large rooms into bathroom-dressing rooms.

In preparation for the "Your Farmhouse" series are bulletins on heating and on planning the kitchen and workroom. The publications now available may be purchased from the Superintendent of Documents, Washington 25, D. C., MP 633 and MP 638 are each 10 cents.

Service Awards. Fifty-four employees of the USDA Divisions of Agricultural Engineering stationed at Beltsville and at 10 field stations have received recognition for one, two, or three decades of service to the Department of Agriculture. George R. Boyd, chief of the Division of Mechanical Processing of Farm Products, and Elmer E. Doolan, head of the purchase and property section, were honored for more than 30 years' service. All of Mr. Boyd's service has been with agricultural engineering, beginning when the work consisted of irrigation and drainage investigations in the Office of Experiment Stations.

West Virginia Notes on a Walnut Meat Pasteurizer, Loose Smut Control, Drying Soaked Grain, Mechanical Gutter Cleaners

By A. D. Longhouse

A WALNUT meat pasteurizer has just been completed and is being tested in a commercial plant at the present time. The $3,000 machine is constructed of plywood and aluminum. Aluminum feed rolls and Neoprene belting make up the principal parts of the conveyor system. A ⅓-hp motor drives the conveyors and the fan which circulates the air within the box. Automatic control of six 500-w, 220-v and four 300-w, 110-v "chromalox" strip heaters supply the heat to maintain a constant temperature of 180 F in the box.

A 60 per cent relative humidity is maintained by using a 2100-w immersion-type heater in a pan of water. A float valve maintains the proper amount of water in the pan.

This machine is capable of pasteurizing approximately 80 lb of walnut meats per hour. One thousand pounds of walnuts were pasteurized before the machine left the department. An additional eight to ten thousand pounds will be pasteurized this season. Preliminary figures indicate that operating costs for electricity alone will be about eight cents per one hundred pounds of walnuts.

Loose Smut Control and Drying Soaked Grain. Controlling loose smut in wheat and barley has been a problem for some time. Objectives in this study are to develop a satisfactory hot water tank with automatic heat control and a drier which will dry the soaked grain as rapidly as possible without injury to germinating qualities of the seed.

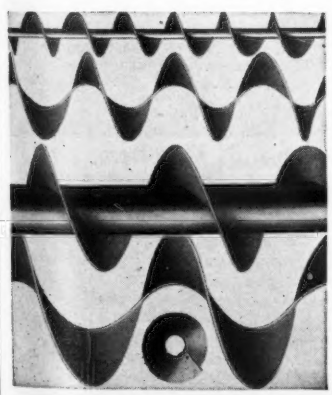
The treating tank is constructed of waterproof plywood. It has one tank for preheating the grain and one tank for the critical temperature bath.

Currently, studies are being made to determine the rate of drying and the temperature at which this drying can be maintained without reducing germination. Trial tests indicate *(Continued on page 224)*

LINK-BELT *Screw Conveyor*

GIVES GENTLE BUT FIRM FEED ON NEW HOLLAND HAY BALER

Below: Available in continuous rolled flight, or in sectional type, and in practically any gage, diameter or pitch, unmounted or welded on pipe of desired size, Link-Belt Screw Conveyor affords the designer many opportunities for utilizing this versatile type of conveyor.



Easier operation and better quality of hay baled, are advantages put forward by the New Holland Machine Company, builders of the "Automaton" Pick-Up Hay Baler. The various advanced features of design include the use of Link-Belt screw conveyor as an auger type feeder. The makers state that this "assures positive feed, which delivers the material to the open baling chamber in a gentle but firm manner without losing the succulent leaves and blossoms."

Link-Belt screw conveyor and screw conveyor flighting, either Helicoid (continuous flight) or sectional, can be supplied in a wide range of sizes, gauges and pitches, either right or left hand.

Screw conveyors are rugged, simple, compact and efficient. Link-Belt, as originators and largest producers of Helicoid continuous rolled flighting, can give you valuable assistance in applying screw conveyors of all types to your various conveying functions.

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NEWS SECTION

A.S.A.E. Annual Meeting

TO ALL intents and purposes the plans for the 41st annual meeting of the American Society of Agricultural Engineers to be held at the Multnomah Hotel, Portland, Oregon, June 21 to 23, are now complete.

The meeting will get under way on Sunday afternoon, June 20, with the beginning of registration, followed by a buffet supper, informal get-together, and entertainment for the evening.

The forenoon of Monday, June 21, will be devoted to concurrent programs on power and machinery, rural electrification, farm structures, soil and water conservation, and by special programs arranged by the College Division and for agricultural engineering students attending the meeting.

The afternoon of the same day will be given over to the first general session of the meeting, the program of which will include the presidential address of Society President George A. Rietz, followed by an address by Harry B. Walker, University of California, on a resume of 16 years of research in sugar beet mechanization. The annual business session of the Society will follow this program.

The evening of the same day will be devoted to a number of round tables sponsored by committees and other groups.

The forenoon of Tuesday, June 22, will feature concurrent programs on power and machinery, rural electrification, farm structures, and soil and water conservation. The afternoon and evening will be given over to a pleasure trip to Timberline Lodge on Mount Hood.

The forenoon of the third day of the meeting, June 23, will be devoted to concurrent sessions of the four major groups of agricultural engineering interest as on the two preceding days, and in the afternoon will be held the second general session which will include addresses by Alfred D. Edgar, U. S. Department of Agriculture, on agricultural engineering problems in Alaska, an address on progress and achievements of rural electrification in the Pacific Northwest by L. J. Smith, State College of Washington, and an address on achievements in the field of irrigation in the Pacific Northwest by F. E. Price, assistant dean of agriculture, Oregon State College.

The Society's annual dinner will be held the evening of June 23, an excellent program for which is being arranged.

Three most interesting field trips have been arranged for Thursday, June 24, for the special benefit of those attending the A.S.A.E. annual meeting. Those persons who are especially interested in power and machinery will see pea liners, vacuum nut harvesters, and fiber flax machinery at Cornelius, Oregon, and vicinity. Those especially interested in soil and water conservation and rural electrification will be taken on a tour to see applications of sprinkler irrigation in the Willamette Valley. The farm structures group will visit a plywood plant and lumber mill at Longview, Washington. All three trips will take the entire day, and the local arrangements committee promises that they will be very much worth while from an educational standpoint.

Printed programs of the meeting and other information regarding it are being mailed to all members of the Society. Non-members may obtain complete information direct from the headquarters of the Society at St. Joseph, Michigan.

Mid-Central Section Organizes

A NEW regional section—Mid-Central Section—of the American Society of Agricultural Engineers was organized at Kansas City on April 30.

With a registered attendance at the meeting of 73 persons, A.S.A.E. members of three states—Kansas, Nebraska, and Missouri—met to organize the Society's newest regional section, the other regional sections of the Society being the North Atlantic, Southeast, Southwest, Pacific Coast, and Pacific Northwest.

Following the naming of the new section and adoption of by-laws, the three-state group of A.S.A.E. members present elected Paul N. Doll, manager, Missouri Limestone Producers Association, as the first chairman of the new section. Three vice-chairmen were elected to represent their respective states in the Section, as follows: L. W. Hurlbut, head, agricultural engineering department, University of Nebraska; H. S. Hinrichs, rural service manager, Kansas Power and Light Company, and K. B. Huff, extension agricultural engineer, University of Missouri. Fred C. Fenton, head, agricultural engineering department, Kansas State College was elected secretary-treasurer of the Section. The nominating committee for the ensuing year consists of Howard E. Everett (chairman), E. A. Olson, and J. M. Ferguson.

In addition to being the organization meeting of the new Mid-Central Section, this meeting was the third and last meeting of the Missouri Section which was disbanded as a state section following the formal organization of the new section.

A.S.A.E. Meetings Calendar

June 21 to 24 — ANNUAL MEETING, Multnomah Hotel, Portland, Oregon.

September 8-10 — NORTH ATLANTIC SECTION, Ontario Agricultural College, Guelph, Ont., Canada.

October 21 and 22 — PACIFIC NORTHWEST SECTION, Columbia Gorge Hotel, Hood River, Ore.

December 13-15 — WINTER MEETING, Stevens Hotel, Chicago.

Georgia Elects Olin Hughes

APPROXIMATELY 45 persons attended the Spring meeting of the Georgia Section of the American Society of Agricultural Engineers, April 16 and 17—a 75 per cent attendance, if they were all A.S.A.E. members—which was held at Myers Lodge, St. Marks, Fla.

Aside from the serious business of fishing, one of the main attractions of the meeting, the group took time out to elect Olin E. Hughes, general manager, Atlanta branch, General Implement Corp., as the new chairman of the Georgia Section. The new vice-chairman of the Section is J. W. Simons, research professor of agricultural engineering at the University of Georgia, and W. D. Kenney, assistant professor of agricultural engineering at the Georgia Coastal Plain Experiment Station at Tifton is the Section's new secretary-treasurer.

Clemson Ag Engineers Happy

ACCORDING to word just received from George B. Nutt, head, agricultural engineering department, The Clemson Agricultural College, the Legislature of the State of South Carolina has just appropriated money to build a new agricultural engineering building on the campus of that institution, which he says, incidentally, leaves the entire staff in a very happy frame of mind.

Agricultural engineers generally will congratulate Mr. Nutt and his associates on this achievement, which in no small degree is the result of the fine job they have been doing in recent years.

Tennessee Section Spring Meeting

THE Spring meeting of the Tennessee Section of the American Society of Agricultural Engineers will be held at the same place it has been held for the past five years—Smoky Mountain Tourist Center, one mile beyond Pigeon Forge, on state highway 71. Those attending will gather Friday evening, May 21, and the meeting will extend to Sunday, May 23.

On Saturday evening there will be a short business session of the Section which will be followed by entertainment under the direction of Julian M. Fore and W. C. Gillham.

The principal features of the meeting will be boating, fishing, hiking, and other forms of recreation. A.S.A.E. members, their families, and interested friends are cordially invited. Cost of rooms and meals is exceptionally reasonable.

Personals of A.S.A.E. Members

Elliott A. Adams is included in a number of changes in the top management of the Massey-Harris Company, Racine, Wisconsin, which have recently taken place. He has been appointed vice-president in charge of engineering. Previously he held the position of chief engineer of the American company.

Fred M. Crawford has resigned as agricultural engineer for the Illinois Northern Utilities Co., to accept an appointment as associate in rural electrification research, University of Illinois.

W. B. Nivison has resigned as regional head, applications and loans division, Rural Electrification Administration, to take over the management of Rural Plumbing and Heating, Inc., Morehead City, N. C.

George B. Nutt was one of a radio broadcast panel of four who discussed "Cotton Mechanization in the Southeast," during the annual meeting of the National Cotton Council of America, in Atlanta. He emphasized the point that tractors, planters, cultivators, and other production machines, as well as harvesters, are important to cotton mechanization. In summarizing he said, "I am optimistic about mechanizing cotton production in the Southeast from land preparation through harvesting. The problems are the same as those presented a few years ago when the grain crop was being mecha- *(Continued on page 224)*

Farm Kitchen Remodeling with Plywood

Farm home of Mr. and Mrs. George Hayden, Stamping Ground, Kentucky

THE VERSATILITY of Douglas fir plywood in farm home remodeling is shown in these pictures of a project conducted by the Agricultural Extension Service, University of Kentucky.

The old farm house of Mr. and Mrs. George Hayden, Stamping Ground, Kentucky, was comfortable and in good condition except for the lean-to kitchen. It was decided to remodel the dining room into a kitchen, and to refinish the old kitchen into a service porch.

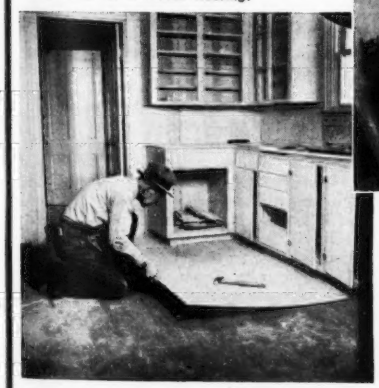
One-quarter inch plywood panels were nailed over the wood paneling in the old kitchen. Panel edges were beveled slightly to form a V at the butted joints, and the panel edges were fitted smoothly around door and window openings without casings or moldings. The plywood surfaces were finished with a resin seal coat, light pastel stain and wax.

In the new kitchen area 1"x4" horizontal furring strips were nailed over the old wall on two foot centers. Similar members were cut between these to back up all vertical panel edges. One-quarter inch plywood was nailed and glued to these strips, using casein glue. Panels of similar thickness nailed to the old worn floor made a smooth base for the new linoleum floor covering. Cabinet work was built on the job using ¾" panels.

The local carpenter had no difficulties in working from the detailed plans and specifications prepared by the extension agricultural engineer. Mrs. Hayden encountered no difficulties in securing attractive paint and stain finishes on the plywood walls and ceiling.

Plywood panels were glued to furring strips nailed to the walls and ceilings. Joints between panels were filled with mixture of glue and sawdust, and sanded flush, making smooth crack-free surfaces.

Plywood panels one-fourth inch thick placed over worn floors make a smooth underlay for linoleum flooring.

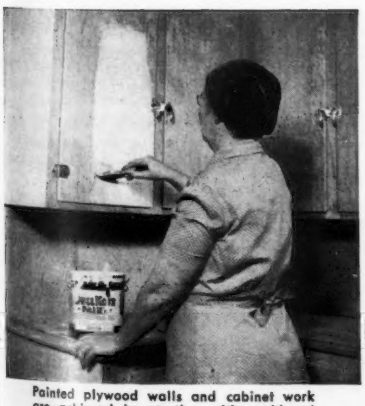


LARGE, LIGHT, STRONG

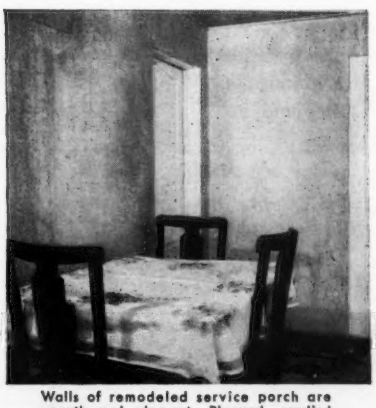
Douglas Fir PLYWOOD

Douglas Fir Plywood Association, Tacoma, Wash.

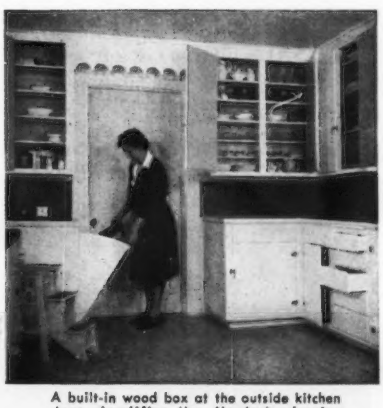
Real Wood Panels



Painted plywood walls and cabinet work are achieved by starting with a thinned prime coat.

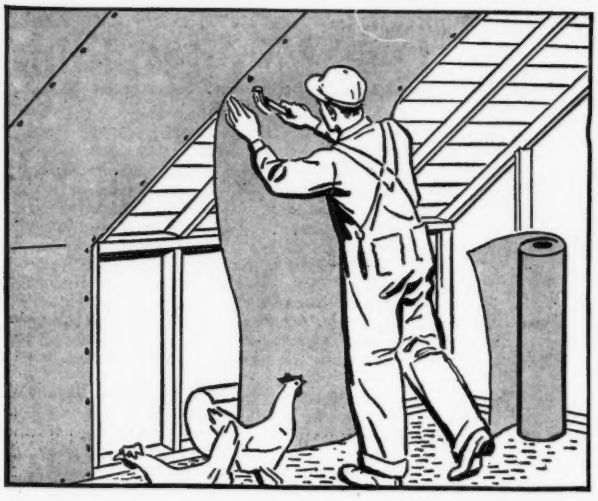


Walls of remodeled service porch are smooth and pleasant. Plywood, applied vertically, was given a light stain finish.



A built-in wood box at the outside kitchen door simplifies Mrs. Hayden's cleaning problem.

HELPING THE AMERICAN FARMER DO A *BETTER* JOB



SISALKRAFT "CASE HISTORIES" OVER A PERIOD OF 20 YEARS IN THE FIELD OF PRACTICAL RESEARCH

Lining Poultry Houses and Other Farm Buildings

From the earliest days of SISALKRAFT on the farm, this tough, strongly reinforced, waterproof, windproof paper product has been used for lining poultry houses, brooder houses, range shelters, etc. Applied to inside studs, SISALKRAFT shuts out wind and moisture, and helps simplify control of ventilation . . . helps keep poultry houses warmer in cold weather, drier, more healthful for the flocks.

SISALKRAFT Practical Research has been continuous . . . aiming always to help the American farmer to do a better job, economically . . . as evidenced by many similar achievements of SISALKRAFT on the farm.

Today, another SISALKRAFT product . . . SISALATION . . . is proving successful as an inside lining for poultry houses. The aluminum surfaced SISALATION is a vapor barrier and insulation combined. SISALATION keeps houses about 15° cooler in summer.

Should you have a problem where a remarkably strong, waterproof paper might be helpful, write Dept. AE

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SISALKRAFT Products are sold by Lumber Dealers throughout America.

Personals of A.S.A.E. Members

(Continued from page 222)

nized. We were told 'that the combine would never be a success east of the Mississippi River.' When a manufacturer saw the potential for a small combine, however, and developed one of the proper size and specifications for the Southeast, it enabled farmers to mechanize grain production. We must have cotton harvesting equipment for small acreages and uneven topography also."

Herbert E. Schleider—a new member of A.S.A.E.—formerly employed as instructor in the Washington County Veterans Vocational School at Brenham, Texas, was recently appointed to the agricultural engineering staff, as assistant agricultural engineer, at the University of Arkanisas and will be engaged on research work on the mechanization of hill farming at the branch experiment station at Batesville, Ark.

M. A. Sharp, head, agricultural engineering department, University of Tennessee, is on leave for a three months' period during which he will be in Greece, conducting training schools in the operation, use, and repair of farm machinery, including the establishment of farm shops for this purpose. His assignment will also include making a survey of existing farm machinery in Greece, of facilities for repair and construction for such machinery, particularly farm shops in rural areas, and working with and advising officials of the Ministry of Agriculture.

G. Sreel Dharan, formerly employed as agricultural engineer by William Jacks & Co., Calcutta, India, now holds a similar position in the agricultural department of Volkart Brothers, Bombay, sole International Harvester dealers in India.

Crop Conditioning Equipment Conference

A CROP conditioning equipment conference will be held May 17, and 18 in Washington, D.C., and at the Agricultural Research Center, Beltsville, Md. It has been called by the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, as a follow-up on last year's corn conditioning conferences, in recognition of the continuing critical food situation, and in furtherance of the Bureau's policy of close co-operation with industries serving agriculture.

The conference will open May 17 at 10:30 a.m. in the auditorium of the Freer Gallery of Art, 12th and Independence Ave., Washington. Introductory remarks will be made by Secretary of Agriculture Anderson, or his representative, on conditioning crops to save food, by W. V. Lambert on research facilities of the ARA, by E. A. Meyer on crop conditioning as related to marketing, and by A. W. Turner on the USDA research program in crop conditioning.

Crop conditioning equipment requirements from the standpoint of the user will be considered during the remainder of the opening session, with specific attention to corn, small grains, oil crops, tobacco, and forage crops.

Continuing in the afternoon, attention is to be given to problems of conditioning as outlined by the RMA committees, drying in relation to seed viability, engineering problems in corn drying, results of corn drying in farm cribs, problems in drying shelled corn, problems in rice drying, and problems of conditioning small grains.

The session Tuesday forenoon, May 18, will open at 9:00 a.m. at the Plant Industry Station at Beltsville. R. A. Salter, chief of the Bureau of Plant Industry, Soils, and Agricultural Engineering, will open the session with a talk on the work of the Bureau.

Conditioning as related to tobacco types and engineering problems in curing tobacco will be the next two subjects on the program, followed by attention to conditioning various types of forage crops, engineering problems in drying forages, and problems of forage curing in Wisconsin.

Other commodities next due for attention as to conditioning are field crops and tung and similar nut crops.

Three contributions on engineering problems in drying oil, nut, and fiber crops will cover soybeans, cotton, and peanuts and tung nuts.

Fire hazards and safety features of farm driers in relation to insurance will be the closing subject on the forenoon program.

Following a lunch at Log Lodge, Agricultural Research Center, the conference will end with a manufacturers' discussion and a tour of the Agricultural Research Center.

A.S.A.E. members on the program include, in addition to Mr. Turner, H. J. Barre, C. A. Bennett, A. A. Brown, H. D. Bruhn, A. W. Cooper, R. B. Davis, Jr., L. E. Holman, W. V. Hukill, E. W. Lehmann, I. F. Reed, and C. K. Shedd.

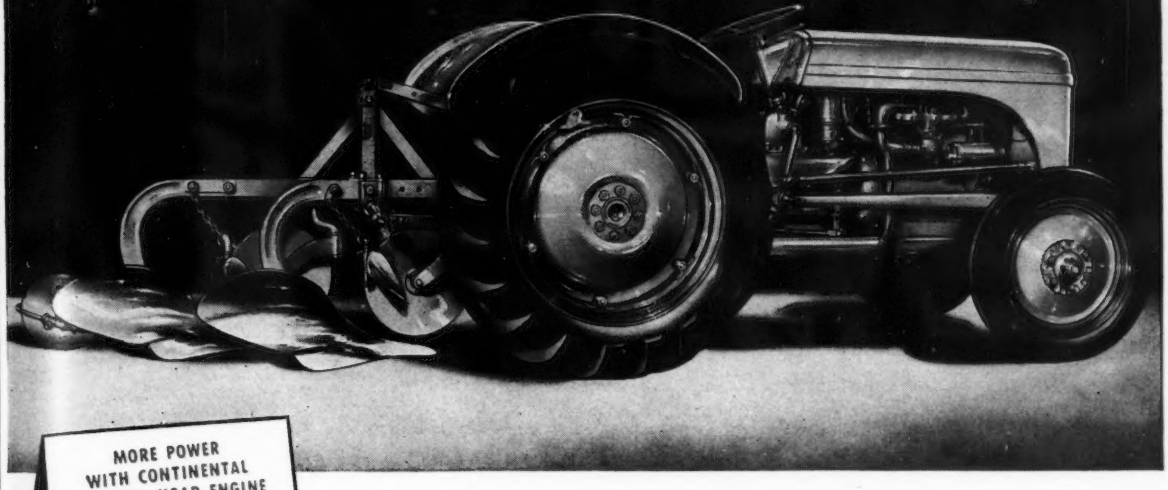
RESEARCH NOTES

(Continued from page 220)

that it may be possible to dry seed barley and wheat at 110 to 120 F in about 4 or 5 hours after treatment in the hot water bath.

Mechanical Gutter Cleaners. The Hope-Flannigan Act has made it possible to start research work on mechanical methods of cleaning in the dairy barn. One 20-in by 75 ft rubber belt installation is now being tested. Preliminary time and motion studies show that the 75-ft gutter for 20 Ayrshire cows can be cleaned in 50 seconds with a 1½-hp electric motor. As soon as this installation is completed, other types will be studied and installed.

Now it's FERGUSON all the way!



MORE POWER WITH CONTINENTAL VALVE-IN-HEAD ENGINE

MORE SPEEDS

AUTOMATIC HYDRAULIC OVERLOAD PROTECTION

HYDRAULIC IMPLEMENT CONTROL

FRONT WHEEL TREAD ADJUSTABLE

* *

No other tractor combines ALL these features

● **FERGUSON TRACTOR**

● **FERGUSON SYSTEM**

● **FERGUSON IMPLEMENTS**

New Ferguson Tractors, with the *one* and *only* Ferguson System as invented, perfected and patented by Mr. Harry Ferguson, are now being delivered in substantial numbers. This fall, with completion of the American tractor plant on which construction is well-advanced at Ferguson Park in Detroit, these powerful, rugged farming machines will be available in still greater supply.

It was in 1937, after 17 years of intensive engineering development that Mr. Ferguson perfected a basic new idea for linking implements to a tractor and controlling them in the soil. In 1939, arrangements were made for mass production of a tractor incorporating Mr. Ferguson's inventions. By June 30, 1947, when these manufacturing arrangements terminated, more than 300,000 tractors incorporating the Ferguson System were in use the world over.

Now comes the new Ferguson Tractor! It is a tractor completely designed by farm-minded *Ferguson* Engineers for high performance and greater operating economy—*more power*, with Continental valve-in-head engine; *more speeds*, with quiet, constant mesh transmission; *greater safety*, with both rear wheels braked from a single pedal, *plus* the automatic hydraulic overload protection provided *only* by the Ferguson System; *greater accessibility*, and many other features for greater economy and convenience. Already, with nearly 50,000 of these new tractors in service, they have been proved unbeatable for easier, safer, lower-cost farming!

FERGUSON SYSTEM

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FERGUSON TRACTOR

AND FERGUSON SYSTEM IMPLEMENTS

For data on the new Ferguson Tractor, write for booklet "E".

Harry Ferguson, Inc., 3639 E. Milwaukee, Detroit 11, Michigan

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Baker, Vernon H.—Graduate fellow in agricultural engineering research, Michigan State College, East Lansing, Mich.

Beekmann, Evert—Design engineer, Food & Agriculture Organization of the United Nations. (Mail) P.O. Box 87, Bolivar, W. Va.

Burton, A. A. N.—Instructor in agricultural engineering, Overseas Food Corp., P.O. Iringa, Tanganyika, Africa.

Cannon, Rowland M. — Agricultural superintendent, Utah-Idaho Sugar Co., Chinook, Mont.

Chinn, Orville W.—Assistant agricultural engineer, Soil Conservation Service, USDA (Mail) Baughman Heights, Danville, Ky.

Dunn, J. E.—Serviceman, R. M. Wade & Co., Portland, Ore. (Mail) 3610 S. W. Moody St.

Edgerly, Gerald O.—Instructor in agricultural engineering research, Michigan State College, East Lansing, Mich.

Einerson, Amos M.—Rural electrification project leader, agricultural engineering dept., University of Wisconsin, Madison 6, Wis.

Harter, V. H.—Sales engineer, Raybestos-Manhattan, Inc., 445 Lake Shore Dr., Chicago, Ill.

Hay, Daniel E., Jr.—Assistant in agricultural engineering (farm structures), Tennessee Coal, Iron and Railroad Co., Birmingham, Ala.

Head, Middleton E., Jr.—Engineer, Geo. W. Timmons Co., 1277 E. Brand St., Columbus, Ohio.

Hill, R. Stanley — Product education manager (western region), Harry Ferguson, Inc. (Mail) 319 Latham Square Bldg., Oakland, Calif.

Holmes, Robert G.—Branch manager, Whitney Chain & Mfg. Co. (Mail) 21 North Loomis St., Chicago 7, Ill.

Huey, Robert B.—Farm consultant on structures, Badger Lumber Co., Marion, Kans.

King, William W.—Agricultural engineer, Willys-Overland Export Corp., Toledo, Ohio (Mail) 1828 Detroit Ave.

Larsen, S. E.—Executive secretary, Michigan Farm Equipment Assn., 515 Murray Bldg., Grand Rapids 2, Mich.

McDow, J. J.—Graduate assistant in agricultural engineering, Michigan State College, East Lansing, Mich. (Mail) P-6, MSC Trailers.

McGilvray, Kermit J.—Division rural service engineer, Alabama Power Co. (Mail) Eufaula, Ala.

Messenger, Edwin R.—Calberta Farms, R. R. No. 2, Caledonia, Ohio.

Osborn, Lynn W.—Manager, Osborn Agricultural Service, 515 Equity Bldg., Muskogee, Okla.

Parker, Henry A.—Sales trainee, A. B. Farquhar Co., York, Pa.

Powers, J. B.—Associate agricultural engineer in the experiment station, University of California, Davis, Calif. (Mail) 235 Third St.

Remines, J. W.—Educational director, Universal Tractor & Equipment Co., Inc., 1519 Summit Ave., Richmond, Va.

Roesler, W. Q.—Agricultural rubber products engineer, Goodyear Tire & Rubber Co., 1144 East Market St., Akron 16, Ohio.

Rogers, A. C., Jr.—Rural service engineer, Alabama Power Co. (Mail) Montgomery, Ala.

Rutherford, Harold E.—Educational manager, Intermountain Tractor Sales Corp., 715 W. 2nd South, Salt Lake City, Utah.

Sands, Earl E.—Production engineer, Dearborn Motors Corp., 15050 Woodward Ave., Detroit 3, Mich.

Stambaugh, G. M.—Manager, replacement sales, farm tires, Dominion Rubber Co., Kitchener, Ont., Canada.

Van Dinter, V. L.—Sales engineer, U. S. Rubber Co. (Mail) Mishawaka, Ind.

Wakefield, Harold R.—Farm representative, Pennsylvania Power & Light Co. (Mail) Griest Bldg., Lancaster, Pa.

Wartes, L. L.—Owner, Empire Engineering Co., 306 Empire State Bldg., and president, Agricultural Appliances, Spokane, Wash.

TRANSFER OF GRADE

Birney, Richard—Civil engineer (design), Soil Conservation Service, USDA (Mail) 2314 W. Horne, Sioux City, Iowa (Junior Member to Member)

Hawkes, Joe S.—Technical service dept., Goodyear Tire & Rubber Co. (Mail) R. R. No. 2, East Gadsden, Ala.

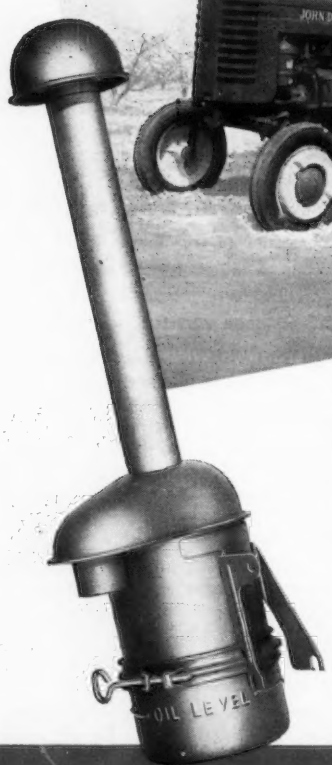
Stokes, C. M.—Associate agricultural engineer, Alabama Polytechnic Institute, Auburn, Ala. (Junior Member to Member)

Joyce, Robert H.—Farmer and rancher, Box 296, Ulysses, Kans. (Junior Member to Member)

Walker, W. R.—Agricultural engineer, development branch, Tennessee Valley Authority. (Mail) 1110 James Bldg., Chattanooga, Tenn. (Junior Member to Member)

KEEPING ABREAST OF POWER PROGRESS . . . . . .

NEW John Deere "M" has dust protection by DONALDSON



This new heavy-duty tractor, like many other farm machines, will operate for a great part of its life under dusty field conditions.

To protect the engine against abrasive dust, to insure longer life, Deere engineers have specified Donaldson heavy-duty, oil-washed air cleaners as standard equipment.

New developments in power machinery often encounter new problems in dust protection. Donaldson research, engineering and testing facilities are available to all manufacturers in solving these problems.

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666 PELHAM BLVD., ST. PAUL 4, MINN.
DONALDSON CO. (CANADA) LTD. CHATHAM, ONTARIO

DONALDSON Oil-Washed AIR CLEANERS

SALES ENGINEERS: CHICAGO • DETROIT • CLEVELAND

NEW HELP FOR AMERICAN FARMERS

...The New John Deere No. 51 Tractor Mower

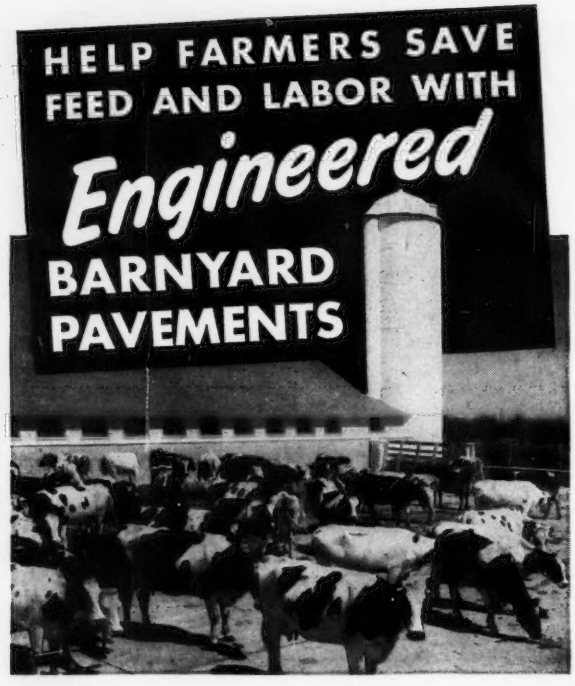
Here's good news for small-acreage farmers. By teaming a new John Deere No. 51 Power Mower, which cuts 25 to 35 acres of hay daily, with a John Deere Model "M" Tractor, they can save time and reduce costs—cut their hay crop at the peak of its feeding value.

This compact power mower is easy to maneuver in fence corners or other "tight" spots. Touch-o-matic hydraulic control raises or lowers the cutter bar at a flick of the tractor operator's hand. A safety spring release protects the mower from damage should the cutter bar strike an obstruction. After it has been released, the cutter bar can be quickly relocked in operating position simply by backing the tractor. Cutting parts are carefully fitted for good work. Simple adjustments for realigning the cutter bar and recentering the knife enable the operator to keep the No. 51 working like new for many years.

Because the No. 51 Power Mower can be attached or detached in a jiffy, it frees the tractor for other jobs during the busy summer season. The big daily capacity of this mower reduces haying time and costs—boosts farm profits. It is one of many new John Deere developments that promise a brighter future for farmers everywhere.

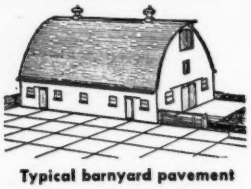
John Deere

MOLINE · ILLINOIS



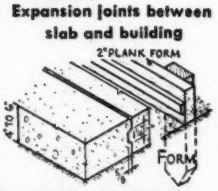
ONE of rural America's biggest problems is producing enough food at low cost to meet domestic and overseas needs. An improvement that will help attain this goal is a concrete-paved barnyard. It takes animals out of the mud and dust; helps keep them healthy. It saves work at milking time and results in a lower sediment test. It saves feed and manure.

A paved barnyard is more than a slab of concrete. It must be engineered for grade, thickness and service requirements. The sketches illustrate a few of the necessary details available to agricultural engineers. Write today for free, helpful "how to build" literature on many profitable, long-lasting concrete improvements. Literature distributed only in U. S. and Canada.

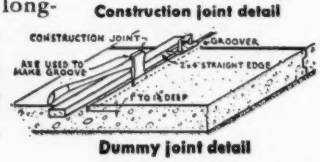


Typical barnyard pavement

Expansion joints between slab and building



Construction joint detail



Dummy joint detail

PORTLAND CEMENT ASSOCIATION

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A national organization to improve and extend the uses of portland cement and concrete . . . through scientific research and engineering field work

Necrology

DAVID PRYCE DAVIES, who served for many years as vice-president and consulting engineer of the J. I. Case Co., passed away on April 25.

"D. P.," as he was known by his many friends in the farm machinery industry, was born in Towyn, North Wales in 1870. His parents moved to America when he was 2½ years old and settled on a farm near Racine, Wisconsin. When he first started to work for the Case Company in 1886, his parents were living on a farm located at the present site of the Case Tractor Works, three miles south of Racine. Most of his life was devoted to the development of tractors with internal-combustion engines for use in agriculture and industry. A long list of patents were issued to him in this field.

He started with the Case Company as a machinist's apprentice, and assisted in building an internal-combustion tractor in 1892, the first gas tractor built in this country for agricultural purposes.

During the years (1897-1910) he was absent from the Case Company, he was sent to Europe by a large manufacturing company to make a complete study of large gas engines operated on the waste gases from blast furnaces. He spent about three years in Europe engaged in this work. On his return, he had charge of installing a large number of these high-powered engines, and many of them are still in operation at some of the larger steel mills.

On February 20, 1940, he was honored by selection as one of a small group which was given a Modern Pioneer Award by the National Association of Manufacturers. Mr. Davies was chosen for this high honor by the Committee on Awards headed by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, in recognition for outstanding contributions to industrial progress through invention and research. In 1942 he was nominated by the Jury of Awards of the American Society of Agricultural Engineers to receive the John Deere Gold Medal.

In addition to his regular work, he was active in the work of The Society of Automotive Engineers, the American Society of Agricultural Engineers, the Army Ordnance Society, and was a member of other fraternal and social groups. He was a 32nd Degree Mason and a Shriner. He was past-president of the St. David Society, and was looked upon as the dean of the tractor engineers in this country.

Survivors are his widow, Martha, one daughter, Beth Davies Lennihan, one son, David P., all of Racine, and three granddaughters.

WILLIAM D. JAMES, president and general manager of the James Manufacturing Co., passed away Friday, April 16, at the Wisconsin General Hospital in Madison.

Mr. James was born in Milwaukee on May 21, 1881, and was reared on a farm near Wales, Wis. He came to Fort Atkinson in 1906, where, with his father, he started the manufacturing company bearing his name. Today the plant occupies three factories in Fort Atkinson and one in Elmira, N. Y.

Mr. James, who guided the company's activities through the meager days, was awarded the Cyrus Hall McCormick Gold Medal in 1942 by the American Society of Agricultural Engineers in recognition of his achievements in the field of engineering in agriculture.

Last year Mr. James was one of five persons honored by the University of Wisconsin for achievement in rural leadership. The award was made during the University's annual farm and home week. His citation of achievement honored him as a "manufacturer of farm equipment to improve the lot of the farmers."

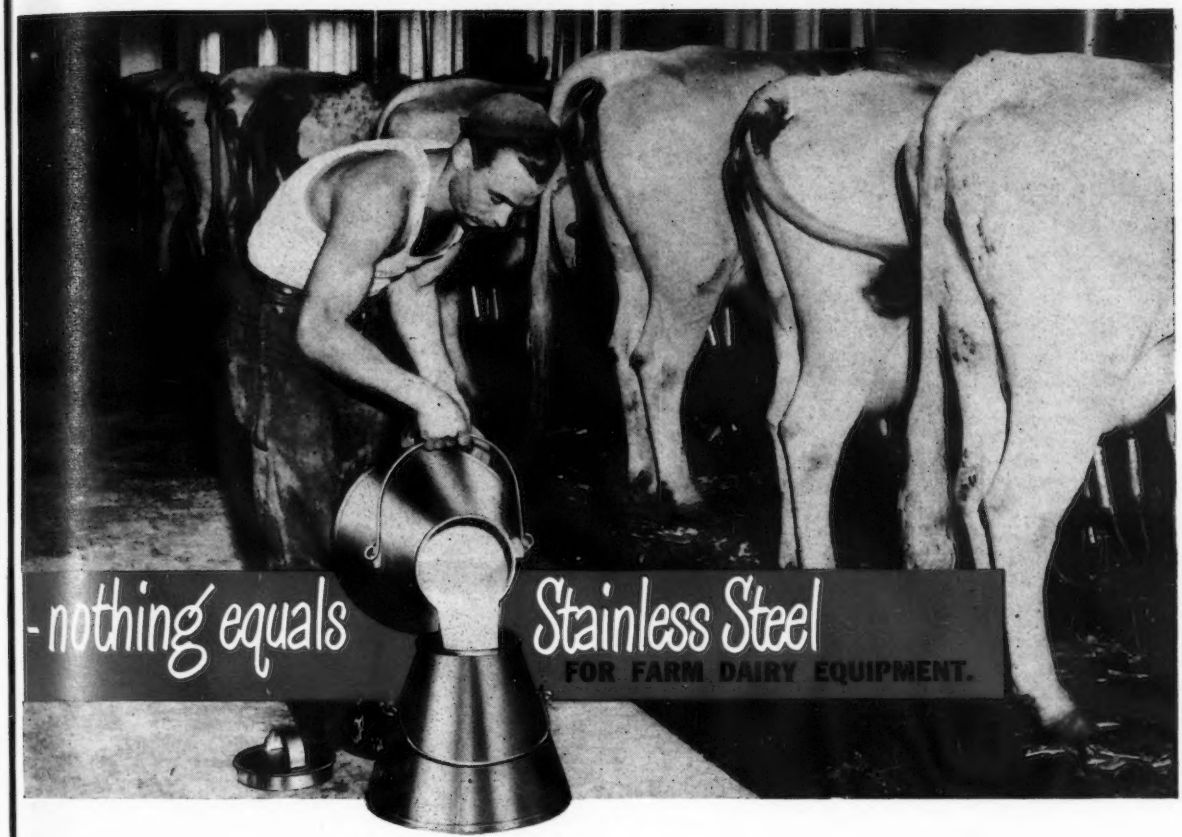
Mr. James, a graduate in 1902 of St. John's Military Academy at Delafield, was a director of the Creamery Package Manufacturing Co. of Chicago, a director of the Wisconsin Manufacturers' Association and the Wisconsin Council of Safety. He also was a member of the National Safety Council, the National Dairy Council, and the Agricultural Committee of the National Fire Waste Council. He served as president of the Wisconsin Manufacturers' Assn. in 1941.

A 33rd-degree Mason, he was a member and trustee of the First Congregational Church of Fort Atkinson. He was a past-president of the local Rotary Club, and was a member of the Union League Club of Chicago and the Madison Club of Madison. He bore the honorary military title of "colonel" bestowed by former Governor Julius P. Heil in 1942.

The survivors include his wife, the former Florence Westcott; his mother, Mrs. D. D. James, and two sisters, Mrs. William Roberts and Mrs. B. F. Zaffke, both of Fort Atkinson.

EARL NEVIN, assistant implement and tractor sales manager, Dearborn Motors Corp., passed away suddenly March 31, at the age of 59. Born at Rossville, Indiana, he first became associated with the farm equipment industry in the Oliver organization, in 1929. From 1933 to 1947 he was with the Allis-Chalmers Mfg. Co., serving in the La Porte, Ind., branch service department as assistant manager of the company's agricultural service department and later as field and experimental engineer. He had become associated with the Dearborn Motors Corp. in July, 1947, and had recently been elected to membership in the American Society of Agricultural Engineers. Mr. Nevin is survived by his widow and one daughter, Mrs. John Platzer, of West Allis, Wis. Burial was in the family plot at Rossville, Ind.

BECAUSE IT IS MORE SANITARY MORE DURABLE ...AND EASIER TO CLEAN ...



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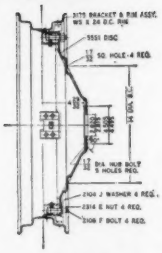

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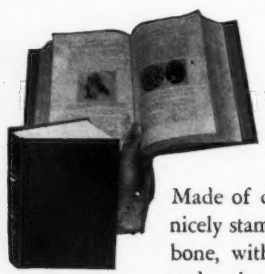

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Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated.

Attention is invited to the desirability of checking on the housing situation when considering a new location.

POSITIONS OPEN: 1947 MARCH—O-543. APRIL—O-552. JUNE—O-569, 571. SEPTEMBER—O-581, 582. OCTOBER—O-588, 589. NOVEMBER—O-592. DECEMBER—O-597, 598, 604. 1948 JANUARY—O-605, 606. FEBRUARY—O-607, 608. MARCH—O-609, 610, 611. APRIL—O-612, 613, 614, 615.

POSITIONS WANTED: 1947 FEBRUARY — W-373. May — W-398, 103. JUNE—W-106. SEPTEMBER—W-119, 120. 1948 JANUARY —W-135, 137. FEBRUARY—W-138. MARCH—W-145, 146, 147, 148, 149, 150, 151, 152. APRIL—W-153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER for technical and extension writing and editorial work with trade association in farm structures field. Midwest location. BS deg in agricultural engineering, or equivalent. Prefer man with 2 or 3 years experience in farm structures field in position requiring considerable writing and editing. Good appearance and personality desirable. Favorable opportunities for advancement. Age 28 - 33. Salary open. O-616

AGRICULTURAL ENGINEERS (2) for teaching service courses in farm structures and in soil and water field in Northeastern State University. BS deg in agricultural engineering or equivalent, from school with high requirements in engineering. Prefer registered engineers or graduates of accredited curriculum. Employment is for academic year of 10 months. Usual personal requirements for college teaching. Age, under 35. Salary open. O-617

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER desires sales work in power and machinery field. BS deg in agriculture with major in agricultural engineering, June 1948, University of Florida. Summer work experience on ranch. Installed drainage system on 10,000-acre ranch. War commissioned service in Air Corps. War injury no longer reduces work capacity. Available June 15. Single. Age 25. Salary open. W-166

AGRICULTURAL ENGINEER desires design, development, or research in power and machinery, rural electric, or farm structures field. BS deg in agricultural engineering, June 1948, Ohio State University. Experience, 3 mo. in parts department, IHC branch, Columbus, Ohio. Part time work at University in construction of a tree planter. Enlisted and commissioned war service in Air Corps weather unit. No disability. Available July 1. Married. Age 25. Salary open. W-167

AGRICULTURAL ENGINEER desires research, extension, or test work in public service, in the soil and water field. BS deg in agricultural engineering, June 1948, Ohio State University; 5-year curriculum with courses in soil physics, mechanics of fluids, agronomy, drainage, irrigation, reclamation, and pond design. War non-commissioned service in Army Airways Communication System. No disability. Available June 15. Married. Age 24. Salary, $3300-3600. W-168

AGRONOMIST desires service work in soil and water field, in private company or public service. BA deg with majors in botany, vegetable crop production, soil management, and agronomy. Experience in inspection of perishable produce. No disability. Available now. Married. Age 28. Salary $2600. W-169.

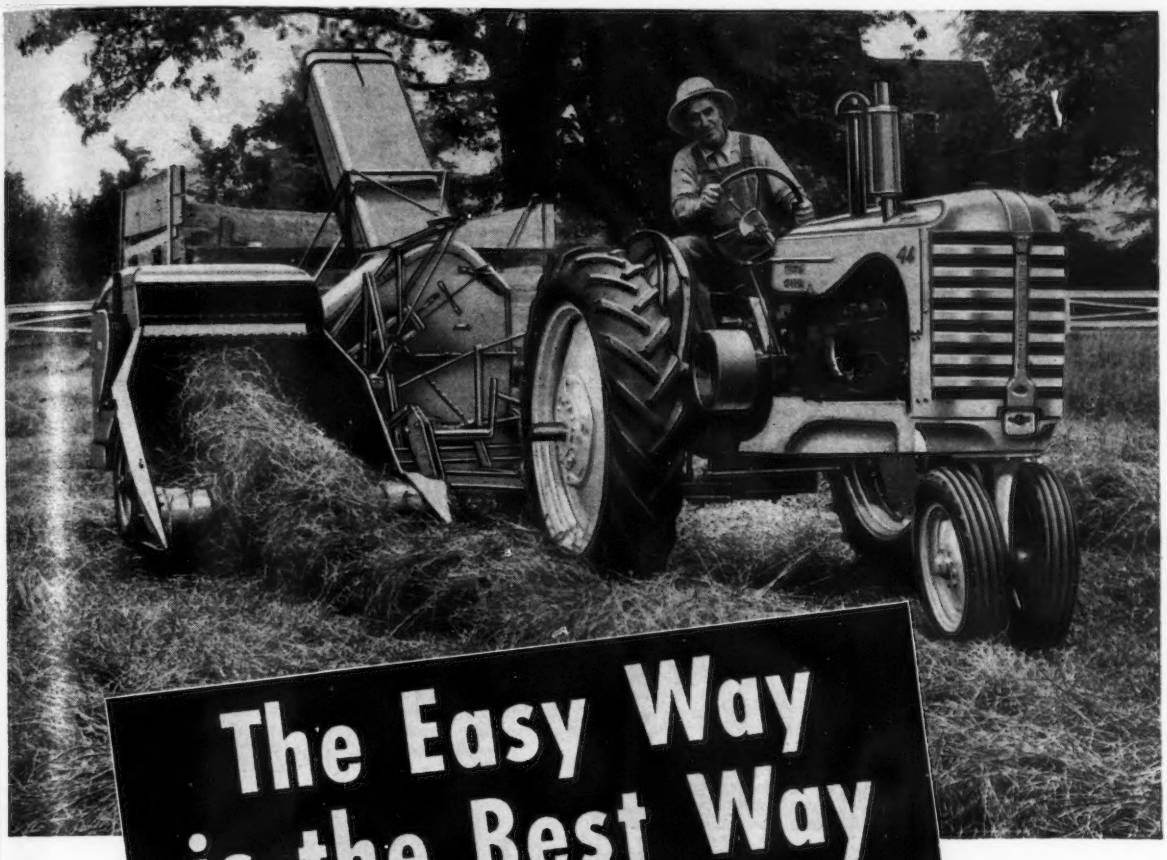
AGRICULTURAL ENGINEER desires design and development work in farm equipment industry or as a government project engineer. BS deg in agricultural engineering, June 1948, University of Maine. Farm background. Experience includes 4 mo as welder, in shipbuilding, and work as mechanic on development of a potato harvester, Agricultural Experiment Station, University of Maine. War service in Navy as Aviation Electronics Technicians Mate 2/c. No disability. Available July 1. Married. Age 25. Salary open. W-170

AGRICULTURAL ENGINEER desires research, sales, or service in power and machinery, farm structures, or product processing field, with private company. BS deg in agriculture, 1947; BS deg in agricultural engineering June 1948, Ohio State University. Experience 3 years in production of hybrid seed corn. War non-commissioned service in army. No disability. Available July 15. Married. Age 29. Salary open. W-171

AGRICULTURAL ENGINEER desires research work in farm structures field, especially in drying hay and grain, in public service organization. BS degs in agriculture and in agricultural engineering, June 1948, Ohio State University. Experience as draftsman and student assistant, agricultural engineering department, Ohio State University. War enlisted and commissioned experience in Corps of Engineers, U. S. Army. No disability. Available July 1. Married. Age 25. Salary $3600. W-172

AGRICULTURAL ENGINEER desires design, development, or extension work, or project engineering in soil and water field, with public service agency. BS deg in agricultural engineering, June 1948, Michigan State College. War experience as pilot in Naval Air Force. No disability. Available July 1. Married. Age 29. Salary $3000. W-173

(Continued on page 232)



The Easy Way is the Best Way

MAKING hay or silage has always been one of the hot, hard jobs. Picture it for a moment . . . the number of operations . . . the time and labor the average farmer spends on it . . . the variety of equipment he needs for it.

Thanks to Massey-Harris engineers, however, there is today an easier way . . . a better way — the Forage Clipper that takes work out and puts quality in.

This single machine cuts, chops, loads any hay or silage crop, ready for blowing into the mow or silo. One man . . . one trip over the field . . . one machine and the whole job is done.

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Following the combine, it picks up straw for bedding, or chops and returns it to the field for plowing under. Many use it for harvesting peas without cracking the pods, and with no time lag between field and viner.

Revolutionary in saving time, labor, and investment in equipment, the Forage Clipper makes for a better product. Faster handling preserves more of the vitamins and nutrients. This means better livestock . . . more economical, more profitable feeding.

Ask the Massey-Harris dealer near you for a copy of "High Quality Forage", written by one of the country's leading animal nutritionists.

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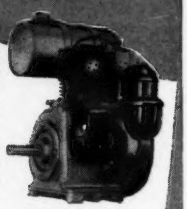
If you build or use any kind of equipment that *is* or that CAN be successfully engine-powered—there is a fairly definite certainty that you can actually increase the productive capacity of the machine by motorizing with a Wisconsin Air-Cooled Engine.

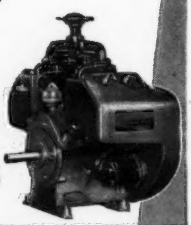
This rather broad statement is predicated on the fact that Wisconsin Engines are notable for continuous, high ratio power output as well as extremely low maintenance and servicing interludes. You are assured of "Most H.P. Hours" of on-the-job operation, thanks to advanced engineering and heavy-duty design and construction.

Wisconsin Engines are worth looking into on all counts. Your interest will be heartily reciprocated.



Typical 4-cycle single cylinder model, 2 to 4 Hp.

Typical single cyl. model, 4 to 9 Hp.



Typical V-type 4-cylinder model, 15 to 30 Hp.

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RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

PERSONNEL SERVICE BULLETIN

(Continued from page 230)

AGRICULTURAL ENGINEER desires work in soil and water field. BS deg in agricultural engineering, June 1948, Michigan State College. Farm background and previous theoretical and practical training in National Farm School. Fluent knowledge of English, French, and Russian. No disability. Available June 15. Married. Age 26. Salary open. W-174

AGRICULTURAL ENGINEER desires development or research work in farm machinery or farm structures field, preferably in private industry in Midwest or East. BS deg in mechanical engineering 1943. BS deg in agriculture 1947. MS deg in agricultural engineering expected in summer 1948, all University of Wisconsin. Farm background; one year, test engineer, experimental aircraft engines; two years part time instructor in agricultural engineering, University of Wisconsin. Ordnance Officer, U. S. Navy, two years. No disability. Available August 1. Married. Age 27. Salary open. W-175

AGRICULTURAL ENGINEER desires work in power and machinery or farm structures field, with private industry. BA deg June 1948, Michigan State College. Farm background. Student assistant in farm structures, agricultural engineering department, Michigan State College. Enlisted and commissioned war service with Army Air Corps. No disability. Available July 1. Married. Age 26. Salary $3000-3600. W-176

AGRICULTURAL ENGINEER desires teaching, research, or both, in power and machinery or soil and water field in land grant college or industry. BS deg in agricultural engineering, June 1948, Ohio State University. One month assisting in research at hydrological research station, Coshocton, Ohio, and three months as half time student assistant instructor in drainage. War non-commissioned service in Army. No disability. Single. Age 23. Salary open. W-177

New Literature

WELDING HELPS FOR FARMERS, edited by A. J. Patch. Cloth, 431 pages, 6x9 inches. Illustrated and indexed. The James F. Lincoln Arc Welding Foundation (Cleveland 1, Ohio). $1.00 in U.S.A., $1.50 elsewhere.

A compilation of methods and suggestions obtained from farmers with successful welding experience, and by other welders who have worked with farmers on farm welding jobs.

Sixteen sections are devoted to the following subjects: the purpose and work of the James F. Lincoln Arc Welding Foundation, farmers quickly become welders, arc welders whittle metal, equipment for welding, setting up the farm workshop, tips on welding methods, repair work with arc welder, welder salvages broken and worn equipment, making equipment for special jobs, tillage tools and posthole diggers, tractors and hitches, carts, trailers, and wagons, manure loaders and other back savers, harvesting tools and elevators, welded forms for many purposes, and shop tools and power saws.

An appendix presents safety rules for shop and farm machine operation and welding training schools. There is also a glossary of welding terms.

Seven agricultural engineers—F. R. Jones, M. M. Jones, E. W. Lehman, G. W. McCuen, I. G. Morrison, Ben D. Moses, and C. W. Smith—served as an editorial board for the publication.

THE USE OF AIRCRAFT IN THE CONTROL OF MOSQUITOES. Sponsored by the American Mosquito Control Association, T. D. Mulhern, Secy.-Treas., (New Brunswick, N. J.), A.M.C.A. Bull. No. 1, 1948. 46 pp. 45 figs. Price, $1.50.

This is the first and only publication dealing with all aspects of this relatively new and highly important line of attack on our insect enemies. Its 67 pages carry condensed authoritative information on all matters relating to the use of aircraft in combating mosquitoes. The usefulness of the publication is not limited to those engaged in mosquito control work, as the major part of the information presented is applicable to any insect problem in which aircraft can be used.

The brief historical section gives facts regarding the early use and development of aircraft for mosquito control, and points out that during 1947 an accumulated total of about 1,000,000 acres was sprayed in the United States.

The various types of planes and equipment for applying insecticides are discussed and well illustrated in 45 photographs and figures. Formulations, specifications and methods of preparing DDT insecticides are given in some detail. Operational procedures and problems are discussed and some of the advantages and limitations of air-dispersal of insecticides are indicated. Methods of measuring results and precautions that should be followedtoavoid injurious effects of DDT on wildlife, beneficial insects and crops are presented. Public relations, legislation and liability as well as civil regulations governing aircraft operations are discussed. Factors to be considered in drawing contracts, report forms, sources of equipment and insecticides, and lists of airplane spraying and dusting services, arranged by states as well as a selected bibliography are included.

The authoritativeness of the information contained in this attractive brochure is assured by referring to the list of contributors.

Contributors include 51 leading authorities in the aeronautical, entomological, engineering, and administrative fields. Their contributions have been edited by a board of five, headed by Col. Paul F. Russell.—*Fred C. Bishopp.*